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SUPPLEMENT TO "THE ELECTRICAL ENGINEER," DEC. 27, 1889.



THE
ELECTRICAL ENGINEER.

A WEEKLY JOURNAL OF ELECTRICAL ENGINEERING,

WITH WHICH IS INCORPORATED

"ELECTRIC LIGHT."

VOLUME IV. (NEW SERIES.)

FROM JULY 5, 1889, TO DECEMBER 27, 1889.

LONDON:

Printed and Published for the Proprietors by BIGGS & DEBENHAM, at "THE ELECTRICAL ENGINEER" Offices, 139-140, Salisbury-court
Fleet-street, E.C.

1889,

Electrical.

VGA
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INDEX TO VOL. IV. (New Series.)

A.

A. B. C. of Electricity, W. H. Meadowcroft, 174
 Accidents caused by Electricity, 43, 63, 116, 225, 244, 250, 382, 450 (see also NEW YORK NOTES)
 ACCUMULATORS, (see BATTERIES, SECONDARY)
 Acheson's Calelectric Generator, 125
 Acme Electric Works, 81, 264
 Admiralty Orders as to Electrical Fittings, 362
 Air, its Electrification by Flame, 346
 Aldershot Gas Works, Explosion at, 221
 Alloy, a Non-Magnetic, 49
 Allsop, F. C., Practical Bell Fitting, 152
 Alternate Currents, Their Conversion into Direct, 386
 Alternate Currents, W. E. Sumpner, 406
 Alternating Currents, Cardew's Safety Device, 62
 Alternator, Brush (American), 72
 Aluminium Alloys, J. H. J. Dagger, 315, 353.
 Aluminium Arc Lamps, 421, 441
 Aluminium Manufacture in Germany, 441
 Amber City, The, T. Vetch, 174
 American Civil Engineers, President's Address, 24
 American Electric Light Association, (see under NATIONAL)
 American Government and the Western Union Company, 82.
 Ammeters, Ayrton and Perry's, Demand for, 141
 Anderson, W., Address to Section G of B. E. E., 255, 293, 318, 328
 Angell, A., Sewage Purification, 291
 Anglo-American Brush Company, Meetings, etc., 58, 78, 100, 102, 122, 139, 282, 319, 440 (see also under BRUSH)
 Anglo-American Telegraph Company, Meetings, etc., 60, 80, 320
 Annealed Iron, Resistance of, H. Tomlinson, 418
 Antilles, French, New Cable to, 482
 Appointments, 101, 182, 321, 341, 342, 361, 404
 Arc Lamp, The Alpha, 444
 Arc Lamp, The Brockie-Pell, 262
 Arc Lamp, Perrin and Masson's, 29
 Arc Light Carbons, Life of, 44
 Arc Lighting after Midnight, 97
 Arc Lighting Prices, 341, 501
 Arc Station, The Perfect, M. D. Law, 177
 Argentine Cable, New, 469
 Armatures, Area of, E. S. Ferry, 213
 ARTISTIC FITTINGS: Abroad, 203; The Globe Company's, 172, 281; General Electric Company's, 464; Verity's, 10, 13, 23
 Arts and Crafts Exhibition, 302
 ARTS, SOCIETY OF: Papers to be Read, 363; Prizes Offered by, 81
 Atkins's Lamp Shade Carrier, 346
 Atlantic Cable, Proposed New, 341
 Attachés, Technical, 481
 Australian Telegraph Tariffs, 101
 Australasian Electric Light Company, Meetings, etc., 78
 Automatic Box Company, 341

B.

Ballooning (Leading Article), 70
 Barcelona, Electrical Shop Opened at, 221

Barking-road, Accident at, 63
 Barrel Hoops, Welding of, 1

BATTERIES, PRIMARY—

for Blasting Work, 181
 Gassner's Dry, 261
 Germain's Cell, 44
 Harris's, 353, 412.
 Jablockhoff's Iron, 462
 Lacombe's, 253
 for Lighting, 164
 Mond and Langer's Gas, 103, 224
 Residues of Bichromate Cells, 1
 Silvey's, 243

BATTERIES, SECONDARY—

by Mr. Bracken, 155
 Another Brush Monopoly, 121
 for Cars in America, 5, 57, 76, 102, 155, 181, 209, 281, 282, 355, 478
 for Cars in England, 264, 484
 Chemistry of, E. Frankland, 348
 and Electric Traction, Julien's System, 162, 174, 209, 281, 363
 Fume Arrestor, 282
 Heyl's, 481
 for Lighting, G. B. Prescott, 395, 416
 a Natural (in Derbyshire), 222
 New Fresh Company, 62
 and Town Lighting, 164, 202, 442
 for Train Lighting, A. S. Brown, 88
 for Use with the Phonograph, 141
 Wölcher's, 382

Belgium, Roller, 462

Beginning of the End (Leading Article), 110
 Belgian Exhibition, Proposed, 421, 463
 Bell, Dr. L., Electric Traction, 7, 27, 53
 Bell and Battery, Dry, 261
 Bell Fitting, Electric, F. C. Allsop, 152
 Bentley-Knight Railway Company's System, 57, 76, 121
 Berlin, Clock Regulation in, 181
 Berlin, Technical School, 281
 Bermuda Cable, 161
 Bichromate Cells, Residues of, 1
 Bidwell, S., Electrification of a Steam Jet, 499
 Birkenhead in Darkness, 221
 Birmingham Exhibition, 1, 61, 75, 81, 111, 141, 142, 161, 163, 201, 224, 235, 281, 314, 339, 341, 381, 402, 502
 Bishop and the Lightning Conductor, 303
 Bismuth Salts, Electrolysis of, A. Watt, 12, 26, 46, 68
 Blair and Blickensderfer's Electric Railway, 109
 Blasting by Electricity, 181
 Bleaching, Electric, 2
 Blight, Electric Cure for, 215
 Blyth, J., New Current-Weigher, 331
 Board of Trade Enquiry re Electric Lighting, 22, 142
 Board of Trade and Overhead Wires, 48, 81, 156, 411
 Boats, Electric (see LAUNCHES)
 Bombay Tramways, 441
 Books Received, 161, 281, 361
 Bottomley, J. T., Expansion of Wires, 19
 Boys' Micro-Radiometer, 282
 Bracken, —, Storage Batteries, 155
 Bradford Lighting Rules, 32
 Brake, Timmins and Forbes', Electric, 154, 463, 484
 Brass and Copper Trades Fund, 342
 Brazilian Cable, New, 61.

Brazilian Submarine Telegraph Company, Meetings, etc., 300, 360, 379, 460
 Bright, Sir Charles, Lease of his Premises, 262
 Brighton, Death by Electricity at, 225, 244
 Britannia Company's Shaping Machine, 381
 British Association, Leeds Meeting, 341.

BRITISH ASSOCIATION, NEWCASTLE MEETING—

Anderson, W., Address to Section G, 255, 293, 318, 328
 Blyth, J., New Current-Weigher, 331
 Dagger, J. H. J., Aluminium Alloys, 315, 353
 Ewing, J. A., Hysteresis, 259
 Excursions Arranged, 84
 Forbes, G., Electric Launches, 258
 Handbooks, 161
 Hedges, K., Precautions in Using Transformers, 236
 Leading Article on, 150
 Magnetisation of Iron, Committee's Report on, 313
 Manville, E., Series Electrical Traction, 238
 Papers to be Read, 162
 Preece, W. H., Telephoning between London and Paris, 249
 Preliminary Programme, 69
 President's Address, 206, 210
 Schuster, A., Passage of Electricity Through Gases, 258
 Stroud, H., E.M.F. of Two Portions of Same Metal, 237
 Swinburne, J., Transformers, 226
 Webber, General, Chelsea Lighting, 272
 Webster, W., Purification of Sewage, 246

Brockie-Pell Arc Lamps, 262
 Brooks, David, A Visit to, 66
 Brooks, D., Conduits and Cables, 427
 Brooks's System of Underground Wires, 101, 231
 Brooks, H. B., Testing Wire Insulation, 369
 Brown, A. S., Train Lighting, 88
 Brown, H. P., and Westinghouse, 181, 184, 202
 Brush (American) Alternator, 72
 BRUSH ELECTRICAL ENGINEERING COMPANY:
 Formation of, 139, 282; and Incandescent Lamps, 42, 50; Meetings of, 60, 80, 320; Switches, 286; Meter, 273
 Brush Monopoly in Accumulators, 121
 Bullets Photographed by Electricity, 442
 Burton's Electric Heater, 3, 142, 344
 Burton, C. V., Theory of Errors, 379
 Business Progress, 23

C.

C & U Motors, 402, 421
 Cable v. Electric Cars, 262
 Cables, Electric Welding of, 463
 Cables, Broken, 221
 Cables, New, 41, 61, 161, 241, 341, 381, 469, 482, 503
 Cables Repaired, 201
 Cables, West Indian, 501
 Cabs, Electric, 183
 Cafés, Ventilators for, 482
 Callender-Webber Mains, 169
 Cancelling Money by Motors, 341
 Carbon Dynamo Brushes, 181
 Carbons, Lacombe's, 242
 Carbons, Life of, 44
 Card Tables for Electrical Engineers, 302, 463
 Cardew's Safety Device, 62

Cardew's Voltmeter, 383
Carriages, Electric, 183
Catalogues, Notices of, 62, 83, 102, 161, 201, 261, 382, 444
"Cause, The, That I Defend," 6
Ceiling Rose, The "Derby," 432
Celluvert, New Insulator, 242, 263
Census Taking, an Electric Tabulator, 205.
Central Asian Telegraphs, 341
Charging Stations on the Thames, 84
Charlesworth and Co., Change of Style, 201
Chelsea Lighting Committee's Report, 179
Chelsea Lighting, General Webber, 272
Chemists, Electric Alarm for, 401
Chicago Doings, 23
Chicago Electrical Club, Speech by Mr. Slatery, 158
Chili, Import Duties in, 322, 444
China, Extension of Telegraph in, 182, 324, 341, 441
Chinese Telegraph Cyphers, 385
CITY AND GUILDS: Old Students' Dinner, 262, 317, 339; Old Students' Journal, 21; Scholarships, 283
City Notes, 20, 39, 59, 80, 100, 140, 160, 180, 200, 240, 259, 280, 300, 319, 340, 360, 380, 400, 420, 460, 480, 499, 512
Clayden, A. W., Lightning Photos, 19
Clocks, Electric, 161, 181
Coal, Direct Production of Electricity from, 224
Coal Mining Machine, 27, 121
Colliery Fittings, 123
Cologne Exhibition, 361
Colonies, Exploiting the, 163
Column Printing Telegraph, 283, 489
Commercial Cable Company, Meetings, etc., 240
Commissioners of Sewers and Electric Lighting, 2, 84, 142, 241, 263, 282, 304, 330, 334, 445
Companies and Corporations, 382
COMPANIES' MEETINGS, REPORTS, ETC.—
Anglo-American Brush, 58, 78, 100, 102, 122, 282, 319, 440
Anglo-American Telegraph, 60, 80, 320
Australasian Electric Light, 78
Brazilian Submarine, 300, 360, 379
Commercial Cable, 240
Consolidated Telephone, 339
Crompton and Co., 40, 400
Cuba Submarine, 80
Devon and Cornwall Electric Light, 160
Direct Spanish Telegraph, 259, 269
Direct United States Cable, 59, 80, 99, 320
Eastern Telegraph, 40, 59, 78
Eastern Extension Telegraph, 259, 320, 339, 500
Edison-Swan, 22, 39, 59, 98
Edmundson's, 240
Electric Construction Corporation, 268, 459
Exeter Electric Light, 63, 77
Falcon Works, 79, 160
Fowler-Waring Cables, 131, 140, 479
Globe Telegraph, 60, 99, 300
Greenwood and Batley, 400
Halifax Cable, 260
India Rubber, 57
Indo-European Telegraph, 360
Keswick Electric Light, 103
London Electric Supply, 57
Maxim-Weston, 489
Metropolitan Supply, 500, 509
Monte Video Telephone, 320, 340
National Telephone, 39, 459
Reuters, 259
South of England Telephone, 19, 380
Swan United, 379, 418
Taunton Electric Light, 345, 399
Telegraph Construction, 39, 58, 341
Telephone of Austria, 280
United River Plate Telephone, 139
United Telephone, 38
West Coast of America Telegraph, 40
West India Telegraph, 340, 380, 399
Western and Brazilian Telegraph, 380
Westminster Electric Supply, 480
Woodhouse and Rawson, 400
Companies, New, Promotion of, 6, 30, 61, 131
Companies, New, Register of, 20, 39, 60, 62, 74, 79, 100, 131, 139, 140, 160, 180, 200, 240, 280, 283, 300, 320, 360, 380, 420, 460, 479, 480, 500
Companies' Share List, 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 320, 340, 360, 380, 400, 420, 440, 460, 480, 500, 512

Compressed Air at Birmingham, 162
Conductors, Heating of, A. E. Kennelly, 195, 446, 467, 506
Conduits and Cables, D. Brooks, 427
Consolidated Telephone Company, Meetings, etc., 339
Constant Current Circuits, Line Wire for, 179
Continental Edison Company's Profits, 101
Continuity Wanting, 162
Coode, Sir J., on Technics, 383
Cooking by Electricity, 62
Copper Mines purchased by Westinghouse, 401
Copper, Separation of Mercury from, 122
Copper, Tempering, 381
County Councils and Electric Lighting, 21, 121
Cowles Aluminium Process, 315, 353
Crompton and Co., Limited, Meetings, etc., 40, 400
Crompton's Conduits, 201
Crompton's Exhibits at Paris, 92, 166
Crossness Sewage Works, 21
Cuba Submarine Telegraph Company, Meetings, etc., 80
Curative Electricity, Congress on, 181
Current-Weigher, New, J. Blyth, 331

D.

Darmstadt Technical College, Prize Offered by, 341
Date Stamp, Electric, 341, 481
Davis and Sons, A Motor to the Rescue, 223
Death by Electricity at Brighton, 225, 244, 250
Deaths from Shocks, 116
Dental Instrument, Electric, 222
Deptford Station, 223, 243, 254, 261, 302, 425, 463
Deputations, 483
Devon and Cornwall Electric Light Company, Meetings, etc., 160
Diamagnetism, S. E. Phillips, 46, 67
Direct Spanish Telegraph Company, Meetings, etc., 259, 269
Direct United States Cable Company, Meetings, etc., 59, 80, 99, 320
Door Alarm, 381
Dowsing, H. J., Reading Lamp, 31
Drug Grinder, Electric, 421
Dundee, 506
Dutton and Co., 302

DYNAMOS—

Carbon Brushes for, 181
Crompton's, 92
Determining Area of, E. S. Ferry, 213
an Electroplater, 347
Foreign Import Duties on, 33
High Pressure, 402
a Huge Shaft, 162
the Ideal, 3
Iron Armatures for, 422
Kapp's Alternator, 116
Lahmeyer's, L. Paget, 326
Lectures by W. B. Esson, 261
New Colossus, 222
Over-Compounding, 421
Poet's View of, 123
Scott and Co.'s, 235, 314
Siemen's, Large, 422
Statter's, 83
Westinghouse, Variation of E.M.F. in, 126

E.

Ear Surgery and Electricity, 122
Eastern Telegraph Company's Meetings, etc., 40, 59, 78
Eastern Extension Telegraph Company, Meetings, etc., 259, 320, 339, 500
Edinburgh Exhibition, 1, 41, 62, 81, 283, 305, 344, 361, 362, 363, 382, 389, 390, 401, 423, 434, 461, 502
Edison: Leading Article on, 130; and the Legion of Honour, 261; in Paris, 124; Strike in Factory, 281; Visit to England, 101; Works at Schenectady, 241
Edison Three-Wire System, W. J. Jenks, 86, 117, 133
Edison-Swan Company's Meetings, etc., 22, 39, 59, 98, 263
Edison-Swan and Brush Companies, 50
Edmunds, H., Illness of, 21
Edmundson's, Limited, Meetings, etc., 240
Egyptian Telegraphs, 501
Eiffel Tower Struck by Lightning, 141, 185
Eiffel Tower, Telegraph Office on, 221

Electrical Apparatus for Belgium, 501
Electric Apparatus Company, Winding up of, 103, 121, 281
Electric Automatic Box Company, 341
Electric Construction Corporation's Works, 385
Electric Fittings, Verity's, 10, 13, 23

ELECTRIC LIGHTING—

for Aberdeen, 201, 482
by Accumulators, G. B. Prescott, 395, 416
for Aldershot, 121, 221
in Alexandrewski Theatre, St. Petersburg, 341
in Algeria, 458, 482
for Alfred Park, Allahabad, 201, 441
in Alliance Theatre, Berlin, 301
at Alnwick Castle, 63
in America, 1, 2, 23, 41, 42, 81, 141, 181, 201, 301, 305, 341
in America, Municipal Control, 462
Arc Station, The Perfect, 177
in Archbishop of Dublin's Palace, 301
Artistic Fittings, 10, 13, 23, 172, 203, 281, 464
for Ashton, 161
in Athens, 341
in Austria, 141, 241, 401, 443
for Ayr, 121
for Bacup, 101, 185, 261, 501
for Ballymena, 402
for Bangor, 121, 122
in Barcelona Theatre, 181
at Messrs. Barker and Co.'s Shops, Kensington, 461
in Barnet, 2, 24, 141, 303, 321, 382
for Barnsley, 223, 242, 265, 281, 321, 423, 461
for Basle and District, 242
in Bath, 442
for Belfast, 102, 184
in Belgium, 381, 421, 462, 481
in Berlin, 201, 382, 441, 461
in Bilbao, 441
for Birmingham, 343, 424
at Birmingham Exhibition, 224
for Birmingham Post Office, 221
in Birmingham, Street Lamps, 461
for Blackburn, 403
in Blackpool, 101, 261, 501
Board of Trade Enquiry, 22, 142
in Bombay, 203, 301, 303
at Bordeaux, 502
in Bordeaux Theatre, 341
in Bourgneuf, 221
for Bournemouth, 121, 141, 181, 261, 301, 321, 365, 381
in Bradford, 32, 121, 143, 183, 230, 245, 272 (Erratum), 281, 323, 344, 461
in Bradford Railway Station, 161
in Breslau, 481
in the British Museum, 222
in Brixton, 401
in Brooklyn, 141
in Brunnen, 183
in Brussels, 421, 462, 481
for Brymbo, 124
in Bucharest, 421
in Messrs. Buck's Works, Wigton, 401
in Budapest, 301
in Buffalo (U.S.), Prices of, 341
of the Bull's Head, Dartford, 482
for Buoys, 422
for Bury, 401
for Burton, 141, 201, 441
for Cadiz, 356, 461
at the Café Frascati, 63
in Calcutta, 61, 144, 164
for Cambridge, 483
in Canton, 482
for Cardiff, 201, 361
for Carlisle, 423
in Cathedrals, 203
in Ceylon, 202
in Charing Cross Shops, 461
for Chatham, 18
in Chelmsford, 82, 185, 362, 382, 402
in Chelsea, General Webber, 272
in Chelsea, Vestry Committee's Report, 179
Chelsea Company's Work, 261
in Cheltenham, 261, 301, 343
for Chester, 121, 142, 261
at Chicago, 23, 81
in China, 81, 164, 382, 402, 482
of a Circus, 114
in the City (London), 2, 84, 142, 241, 254, 263, 282, 304, 334, 445
in Clay Cross Coal Mines, 201
and the Commissioners of Sewers, 2, 142, 241, 263, 282, 304, 330, 334, 445

ELECTRIC LIGHTING (*continued*):—

Companies and Corporations, 382
in Copenhagen, 342
and County Councils, 21, 121
for Coventry, 104
at Cowpen, 101
for Croydon, 341
in Cuxac d'Aude, 421
of the Czar's Train, 404
Daily News on, 282
Dangers of Overhead Wires, 382, 450
in De Beer's Mine, Kimberley, 22
and Deep-Sea Fishing, 304
in Denmark, 342
Deptford Station, 223, 243, 254, 261, 302,
425, 463
Deputations, 483
for Derby, 421
in the Devonshire Club, 282
for Doncaster, 261
for Dover, 41
for Dublin, 4, 81, 121, 159, 181, 199, 216,
222, 261
in Duluth (U.S.), 42
for Dumbarton, 41
in Dundee, 42, 261, 321, 323, 377, 442, 484,
504, 506
in Eagle Potteries, Hanley, 362
at Eastbourne, 142, 463
for Edinburgh, 221, 341, 421
in Edinburgh Exhibition, 401, 461
in Egypt, 341
in Einsiedeln, 183
in Exeter, 63, 261, 441
in Exeter Theatre, 62, 285, 502
Extraordinary (in Derbyshire), 222
for Fareham, 281
in Field and Son's Shop, Aylesbury, 224
and Fire Risks, J. A. Jamieson, 478
Five-Wire System, 204
in Flensburg, 181
at Florence, 509
for Folkstone, 141
in Formosa, 141
in France, 2, 22, 41, 42, 63, 142, 181, 221,
421, 443, 461, 481
French Regulations, 443, 461
in Gartnavel Asylum, 362
and Gas, 124, 141, 143, 144, 161, 171, 182,
190, 222, 265, 284, 322, 401, 422, 443
Gatti's Station, 168, 322
in Gènes, 181
in Germany, 141, 181, 201, 204, 301, 382,
401, 441, 443, 461, 481
in Ghent, 381
for Glasgow, 321, 364, 464
of Glasgow Victoria Infirmary, 462
in Globe Theatre, 461
for Gloucester, 261
for Gravesend, 384
for Great Yarmouth, 325
at Grove House, Tipperary, 362
for Hall-sur-Saal, 461
in Hanover, 481
for Harrogate, 324
for Hastings, 222, 421, 445, 481
in Helouan Casino, 341
for Hereford, 122
at Hetton Colliery, 464
High or Low Tension, 264, 364, 470
for Holborn, 141, 242, 261
in the Houses of Parliament, 422
in Huddersfield, 161, 201
in Hungary, 301, 401
in India, 61, 144, 164, 201, 203, 301, 303,
304, 441
in Innsbruck, 443
Inspector for London, 444, 464
of Ipswich Cattle Show, 481
in Italy, 202, 384, 402, 441
in Jamaica, 201
in Japan, 162
in Johannesburg, 164
Jobbery in, 322, 350
for Keighley, 301, 382
in Kensington (Chelsea Company's Dis-
trict), 261
in Kensington, Explosion, 361
at Kensington, Adoption of Three-Wire
System, 182, 204
for Kensington Town Hall, 81
at Keswick, 103, 121
for Kidsgrove, 101
for Kingston and District, 102, 222
for Kingstown (Jamaica), 201
in Koenigsberg, 204, 401
in Kongsberg Silver Mines, 21
at Kurrachee, 501
at Lakeside (Minn.), 1

ELECTRIC LIGHTING (*continued*):—

and Lambeth Vestry, 64, 464
in Langlaagte Gold Mine, 441
for Launceston, 143
in Leamington, 265, 405, 432, 482
in Leamington Pump Room, 321, 401
Lectures by W. B. Esson, 221
Lecture by Lant Carpenter, 483
in Leeds, 34, 241, 263, 323, 381, 421
for Leeds Town Hall, 224, 241
for Leicester, 163, 262
for Levenshulme, 381
in Lighthouses, 183
for Lincoln, 121
in Lincoln's Inn, 483
at Lisbon Dock Works, 21
in Liverpool, 222
in Liverpool, Inspectorship of, 143, 182
for London Bridges, 42
in London, Companies' Bills, 24, 42, 44, 65,
102, 121, 141
for London (Mr. Judge on), 44
in London (south and west), 110
and the London County Council, 299, 325,
403
of the Lord Mayor's Carriage, 361
on the "Lynx" and "Antelope," 101
for Madrid, 283, 402
in Maharajah of Gaekwar's Palace, 304
for Maidstone, 63
for Manchester, 4, 21, 121
for Manila, 482
in Marienbad, 143
for Mauritius, 123
at Melbourne Exhibition, K. L. Murray
392, 412, 436
for Melun, 181
Metropolitan Company's Work, 168
in Metz, 141, 441
after Midnight, 97
for Mines, Colliery Fittings, 123
in Monte Video, 401
of Mr. Monteith's Premises, Leeds, 363
Moral of the Gas Strike, 490
in Moore and Burgess's Hall, 481
for Morecambe, 143
in Moscow (U.S.), 201
on Mount Killimanjaro, 163
and the Naval Manœuvres, A. Phantom
Ship, 165
in Newcastle-on-Tyne, 161, 202, 363, 386,
435, 443
for Newcastle-under-Lyme, 361
for Newry, 321
in New York, 301
in New Zealand, 181, 477
of Colonel North's Mansion, 184
for Northfleet, 382
in Norway, 21
for Norwich, 182, 201
Notes on, E. J. Silcock, 35, 51
for Nottingham, 281, 381, 421
in Okehampton Baptist Chapel, 141
in Ottawa and Marseilles (U.S.), 305
for Paddington, 121, 244, 284, 442
for Paisley, 401
of the Palace of Industry, 22
in Paris, 41, 42, 142, 171, 341, 421, 426,
443, 444, 461, 481
of the Paris Exhibition, 61
in Paris Railway Stations, 63, 181, 442
Parliamentary Proceedings, 25, 42, 44, 65,
102, 121, 141
in Partick, Hillhead, etc., 161
Pavement Plates, 282
for Penrhyn, 182
for Penzance, 361
for Peterborough, 61
in Philadelphia, 41
in Pittsburgh, 181
for Plymouth, 121, 143
at Pontardawe, 285
for Poole, 102
in Portsmouth, 281, 301, 481
for Portsmouth Dockyard, 465
Primary Battery Plant, A. 164
Progress in, 104
in Provins (France), 481
Provisional Orders Applied for, 381, 402,
430, 457
Provisional Orders and Local Authorities,
25, 42, 44, 64, 101, 121, 122, 123, 141,
142, 143, 161, 163, 182, 185, 201, 221,
222, 241, 261, 263, 281, 283, 284, 301,
302, 321, 324, 341, 343, 361, 381, 382,
383, 401, 403, 421, 423, 430, 441, 442,
443, 461, 462, 463, 464, 481, 482, 483, 484,
501
at Puente Genil, Spain, 181

ELECTRIC LIGHTING (*continued*):—

in Railway Foundry, Barnsley, 361
in Reading, 181, 421
Reporting Progress, 168, 204
for Richmond (Surrey), 401, 485
in Messrs. Ridley's Mills, Chelmsford, 283
for Rochdale, 301
for Rochester, 142, 321, 481
in Rome, 202, 384
in Ronda (Spain), 441
for Rotherham, 201
and Rotherhithe Vestry, 1
in Rufford Abbey, 163
in Russia, 341, 482
on Russian Warships, 341
in St. Austell, 401
for St. Helens, 443
in St. Hilaire du Harcouet, 2
for St. James's, 123, 303
St. James's Company's Work, 169
on the "St. Lawrence," 181
and St. Martin's Vestry, 241, 322
in St. Petersburg and Moscow, 482
in St. Ursula's Convent, Olmutz, 221
for Salford, 261
Sardinia-street Station, 483
of the Savoy Hotel, 251
in Sawmills at Leith, 82
in Seatwell Mansion, 302
and Scotch Corporations, 443
in Segovia, 221
on the Seine Boats, 1
for Sevenoaks, 341
at Sewerage Works, 142
in Shanghai, 81, 164
in Sheffield, 181, 263
for Shields, 162
on Ships, 1, 21, 101, 181, 198, 341, 362, 50
Size of Wire for Constant-Current Circuit,
179
in South Africa, 22, 164, 441
in South Yorkshire, 409
at Southend, 201
for Southampton, 143
for South London, Provisional Order Aban-
doned, 81, 101
for Southport, 221
in Spain, 21, 143, 181, 283, 341, 356, 441
461
at the Spanish Exhibition, 61, 362
in Springfield Mills, Morley, 361
for Stafford, 267, 343
in Messrs. Stevenson's Bakery, 281
in Stockholm, 141
for Stockton, 101, 261
for Stoke, 383
for Stoke-on-Trent, 201
Storage System, 164, 202, 442
in the Strand, 342, 402
in Swan Hotel, Shillingford, 141
in Sweden, 141
in Switzerland, 1, 183, 201, 441
Switches, Brush Company's, 286
for Sydney, 222
at Taunton, 22, 345
Tenders Invited for, 81, 123, 143, 222, 242,
356, 401, 442, 482
on Thames Steamers, 198
in Theatres, 62, 181, 285, 301, 341, 461
462, 501
in Tivoli, 402
in a Tomb, 221
on Trains, 201, 241, 402, 481
Trials at Woolwich, 21
in Trieste, 401
Turning Down Lamps, 203
for Tynemouth, 302, 443
for Underground Railway, 301
in Venice, 441
in Versailles, 461
Messrs. Verity's Work, 23
in Vienna, 141, 241, 341, 391, 401, 501
for Walsall, 263
in Walthamstow, 341
in Warsaw (U.S.), 41
for Washington (U.S.), 201, 341
and Water Colours, 363
for Wednesbury, 481
at Wellington (N.Z.), 181
for Whitechapel, 482
for Weston-super-Mare, 261
in Wiesbaden, 443
for Wigan, 461
for Wimbledon, 381
for Wimbledon, Richmond, and District, 3
for Windsor, 301, 381, 422
at Woking, 261
for Wolverhampton, 2, 182, 376, 401
for Worcester, 222, 283, 462

ELECTRIC LIGHTING (*continued*):—
in Wrexham, 101, 121, 241
in Yldiz Kiosk Palace, Constantinople, 342
for York, 383, 483
for Zurich, 1, 201, 441

Electric Construction Corporation, Meetings,
etc., 268, 459
Electric Piano, 503
Electric Shooting, 22
Electric Supplies, 282
Electric Surgery, 122
Electric Traction Company's System, 264, 421
Electric Traction and Horseflesh, 410, 483
Electric Traction Problems, Dr. L. Bell, 7,
27, 53
Electric Traction (*see also* RAILWAYS AND
TRAMWAYS, ELECTRIC)
Electrical Accessories Company, 282
Electrical Apparatus, Extension of (Leading
Article), 90
Electrical Applications, F. Bain on, 323
Electrical Construction and Maintenance Com-
pany, Meetings, etc., 262, 268, 270
Electrical Distribution, Pamphlet on, 64
Electrical Engineer Drowned, 363

ELECTRICAL ENGINEERS, INSTITUTION OF—
Addenbrooke, Electrical Engineering in
America, 453, 474, 498
Council Balloting List, 452
Dinner given by Sir W. Thomson, 342,
366, 370
Meeting in Paris, 41, 141
Murray, Melbourne Exhibition Lighting,
392, 412, 436

Electrical Engineering in America, G. L.
Addenbrooke, 453, 474, 498
Electrical Engineering, Future Prospects of, 24
Electrical Machinery, Mechanical Details of,
132

Electrical Managers, 271
"Electrical Plant," 283, 420
E.P.S. Co., Award to, 261

ELECTRICITY: in Africa, 163; Dangers of,
225, 244, 250; a Decade's Progress, 104;
Direct Production of, 224; and the Engi-
neering Trades, 403; Taxing, 183; and War,
182

Electricity in our Homes, S. F. Walker, 251
Electricity, Ideal Plan of Supplying, 170
Electricity, Modern Views of, O. J. Lodge, 71,
151

Electro-Harmonic Society, 242, 343
Electrolier, A Striking, 41
Electrolysis, Initial Phase of, 43
Electrolytes, Dissociation of, 424
E.M.F. of Two Portions of Same Metal, H.
Stroud, 237

Electroplating on Glass, 162
Elliott Bros., Exhibits at Paris, 146
Elliott Bros., Standard Resistance Box, 449
Elliott, Sir G., Appointed Chairman T. C. &
M. Co., 341

Engine-Room Telegraph, Willis's, 147
Engineering, A Faculty of, 404
Engineering Society, Junior, Address by Prof.
Perry, 306, 310

English Measuring Instruments, 141
Enright, J., Contact of Gases and Liquids,
379, 418

Errors, Theory of, C. V. Burton, 379
Escher, Wyss, and Co., 441
Esson, W. B., Lectures on Electric Lighting,
221

"Eta" Launch, Records by, 225
Evans, G. T., Wiring Calculations, 91
Ewing, J. A., Hysteresis, 259
Exchange Telegraph Company's New Tape
Machine, 323

Execution by Electricity, 43, 85, 123, 141,
181, 184, 202, 250, 301, 421
Exeter Electric Light Company, Meetings, etc.,
63, 77

Expansion Gear, Ransomes', 349
Explosion in Kensington, 361

F.

Facetiae, 509
Falcon Works Company, Meetings, etc., 79,
160, 182
Farming and Electricity, 401
Ferranti's Cables, 463
Ferry, E. S., Area of Armatures, 213
Filaments, Form of, C. J. Reed, 496, 504
Finsbury College Programme, 81, 244

Fire Alarm, Automatic, 223
Fire Alarms for Hornsey, 302
Fire Brigade Bells, Sax's Tender for, 361
Fire Risks, J. A. Jamieson, 478
Fires and Rumours, 450
Fishing, Deep-Sea, by the Electric Light, 304
Fishing, Electric, 1
FITTERS, ARTISTIC: Abroad, 203; General
Electric Company's, 464; Globe Company's,
172, 281; Verity's, 10, 13, 23
Five-Wire System, 401
Florence, Tender for Lighting, 509
Flower, Prof., Presidential Address to British
Association, 206, 210
Forbes, G., Electric Launches on the Thames,
258
Fountains, Luminous, at Vienna, 461
Fowler-Waring Cables Company, 131, 140, 479
Frankfort Exhibition, 442
Frankland, E., Storage Batteries, 348
Franklin Institute, Medals Awarded by, 142
French Accumulator Company, New, 62
French Guinea, New Cable for, 482
French Regulations for Electric Lighting, 443
French Submarine Cable Company, 482
French Telegraphs, 381, 401
Fume Arrester, A, 282

G.

Gas Battery, New, 103
Gas and Electric Lighting, 124, 141, 143, 144,
161, 171, 182, 190, 222, 265, 284, 322, 401,
422, 443

Gas Manager on Electricity, 122, 190
Gas Manufactured by Electricity, 242
Gas, Prepayment for, 202
Gas Strike, the Moral of, 490

Gases and Liquids, Contact of, J. Enright,
379, 418
Gases, Passage of Electricity Through, A.
Schuster, 258

Gasholder Blown Over, 441
Gatti, Messrs., and St. Martin's Vestry, 322
Gatti's Central Station, 168
General Electric Company, 82, 100

General Electric Company's Artistic Fittings,
464
General Electric Company, Card Tables Issued
by, 302, 463

German Telegraph Works in Difficulties, 3
Germain's Battery, 44
Gilbert Club, The, 404, 459
Glasgow Students' Appointments, 404
Glasgow Technical College, 261

Glass Blowing, 61
Glass, Electroplating on, 162
Globe Company's Artistic Fittings, 172, 281

Globe Electrical Company's Exhibits at Paris,
166
Globe Telegraph Company, Meetings, etc.,
60, 99, 300

Globes for Lamps—Electric Grapes, 402
Gold Extractor, Cousen's, 263
Goldston's Series Incandescent Lamp, 129,
182, 224

Gooch, Sir Daniel, Death of, 311
Goods Traffic, Slow, 63
Goodsall v. Pender, 83

Graphic, The Daily, 442
Gray, J. K., Death of, 423
Great Yarmouth, Report on Electric Lighting,
325

Great Western Railway and Postmaster-Gen-
eral, 138
Greenwood and Batley, 400
Gregory, W. G., Driving Tuning-Forks, 378

Gregory, W. G., Radiation Meter, 378
Grosvenor Gallery Wires, 21
Groth's Electric Tanning Process, 343, 364,
441

Gymnote, The, 461

H.

Halifax, Cable Company, Meetings, etc., 260
Hall, Walter, Death of, 421
Harbour Lights, 422

Harris's Primary Battery, 353, 412
Heat, Electric Measurement of, 282
Heater, Burton's Electric, 3, 142, 344

Heating of Conductors, A. E. Kennelly, 195,
446, 467, 491, 506
Hedges, K., Precautions in Using Trans-
formers, 236
Hedges's Exhibits at Paris, 166
Heisler System, The, 2, 141, 303, 305, 321, 382

Henley's Telegraph Works, 472
Hermite's Electrical Sewage Treatment, 144
High or Low Tension, 264, 364, 470
Hollerith's Tabulating System, 205
Honolulu Cable, 41
Hopkinson, Dr., Report on the Dundee Light-
ing, 504
Hopkinson, J., Non-Magnetic Alloy, 49
Horseflesh, Electricity and Labour, 410
Human Body, Resistance of, A. E. Kennelly,
132
Hungarian Telegraphy, 301
Hysteresis, J. A. Ewing, 259

I.

Ignorance is Bliss, 250
Import Duties, Foreign, on Dynamos, etc., 33

INCANDESCENT LAMPS—
Atkins's Shade Carrier, 346
Backstrom's, 61
Brush Company and the Manufacture of,
42, 50
for Buoys, 422
Demand for Sawyer-Mann, 421
Edison's High Resistance Filament Patents,
122
Form of Filaments, C. J. Reed, 496, 504
Frosting, 445
Goldston's Series, 129, 182, 224
Maximum Efficiency of, 188
Patents for Holders, 322
Pieper's, 163
Prevention of Blackening, 121
of 3,000 c.p., 241, 261
Turning Them Down, 203

India Rubber Company, Meetings, etc., 57
India Rubber Company's Works, Strike at,
241, 264, 292, 431, 471

Indian Telegraphs, 161, 221, 321
Indo-European Telegraph Company, Meet-
ings, etc., 360
Induction on Telephone Lines, J. J. Carty
447

Induction, Thomson's Experiments, 204
Industries, Removal of Offices, 221
Insulated Wire, Henley's Works, 472

Insulating Staple, New, 62
Insulation of Wires, Testing, H. B. Brooks
369

Insulator, New, Cellvert, 242, 263
Insulators, Wholesale Damage to, 41
Ireland, Light Railways for, 62

Iron, Annealed, Resistance of, H. Tomlinson,
418
Iron Armatures for Dynamos, 422
Iron, Magnetisation of, Report of B. A. Com-
mittee, 313
Iron-Nickel Alloy, A Non-Magnetic, 49.
Italian Business, 283

J.

Jablochkoff's Iron Battery, 462
Japan Electrical Companies, 162
Jenks, W. J., Edison Three-Wire System, 86,
117, 133

Jensen Bell Company, 61, 141
Joule, Dr., Death of, 311, 442
Joule, Dr., Statue to, 501

Journals, New, 2, 363, 442
Julian's Electric Alarm Gauge, 192
Julien Company's System of Traction, 162,
174, 209, 281, 363

Junior Engineering Society, Address by Prof.
Perry, 306, 310

K.

Kapp's Alternator, 116
Kennelly, A. E., Heating of Conductors, 195,
446, 467, 491, 506

Kennelly, A. E., Resistance of Human Body,
132
Kensington, Explosion in, 361
Keswick Electric Light Company, Meetings,
etc., 103

L.

Lacombe's Arc Carbons, 242
Lacombe's Battery, 253
Ladder with Extending Platform, 241
Lahmeyer's Dynamo, L. Paget, 326

Lamp-posts, Reduction in Price, 201
Lamp-Shade Carrier, Atkins's, 346
Launch-Charging Stations on the Thames, 84
Launches, Electric, 101, 225, 321, 344, 461
Launches, Electric, on the Thames, G. Forbes, 258

Law, M.D., Perfect Arc Station, The, 177
Lead-Covered Cables, 21, 49

LEADING ARTICLES—

Agreement (Brush Company and Edison-Swan), 50
Ballooning, 70
Beginning of the End, 110
Bradford, 230
British Association, The, 150
Company-Mongering, 30
Dundee, 506
Edinburgh Exhibition, 390
Edison, 130
Extension of Electrical Apparatus, 90
False or True (Provisional Orders), 430
Fires and Rumours, 450
Fowler-Waring Cables Company, 131
High or Low Pressure, 470
Horseflesh, Electricity, and Labour, 410
Ideal Plan of Supplying Electricity, 170
Institution Dinner, The, 370
Moral of the Tale, The, 490
Other Side, The (Jobbery in Electric Lighting), 350
"Out for an Airing," 30
Patents, 11
Perry, Prof.: His Address to Junior Engineering Society, 310
President's Address, British Association, 210
Refer it Back (City Lighting), 330
Silvertown Strike, 431
Strike Wave, The, 290, 431
Topics of the Moment, 270
Weathercock and Barometer, 190
"Where Ignorance is Bliss," 250
Woodhouse and Rawson, 71

LEGAL—

British Tanning Company v. Groth, 441
Brush and Edison-Swan Companies, 50
Column Printing Telegraph Company v. Exchange Company, 489
Edison's Filament Patents, 122
v. Electrical Apparatus Company, 103
Julien's Battery Patents, 363
Lighting of Mr. Monteith's Premises, Leeds, 363
Postmaster-General v. Great Western Railway, 138
Steed v. Appleton and Co., 482
United Telephone Company v. Ahern and Co., 18; v. Brierley, 22; v. Liversedge and Co., 22, v. Norton, 241; v. Smith, 362

Light, Prepayment for, 202

Light, Who Will Furnish it, 422

Lighthouse, A Gigantic, 183

Lighting After Midnight, 97

LIGHTNING: Accidents from, 141, 181, 185;
Conductor and the Bishop, 303; Conductors
in Chelsea, 243; Photos of, A. W. Clayden, 19

Lightships, Communication with, 43

Lisbon, New Telegraph Office, 1

LITERATURE—

Allsop, F. C., Practical Ball Fitting, 152
Lodge, O. J., Modern Electricity, 71, 151
Meadowcroft, W. H., A B C of Electricity, 174
Vetch, T., Amber City, 174
Walker, S. F., Electricity in Our Homes, 251

Liverpool Lighting Inspectorship, 143, 182

Liverpool Physical Society, 342

Liverpool Supply Company's Annual Excursion, 43

Liverpool University Engineering Laboratory, 383

Lodge, O. J., Modern Electricity, 71, 151

LONDON CHAMBER OF COMMERCE: New
Members, 61; Report on Electric Section,
7, 362, 434; Standard Types, 75; a Stan-
dardising Laboratory, 64, 149

London County Council, 122, 299, 325, 361,
381, 403, 462, 488

London Electric Supply Corporation, Meet-
ings, etc., 57, 263

London, Lighting Inspector for, 444, 464

London Subways, 462

Lubricator, New, 63
Lyons Tramways, 241

M.

Machine Driving by Electricity, 192
Machinery, Rating of, 241
Mahdi's Tongues of Flame, 442
Madras Tramways, 163
Madrid Electric Light Company, 402
Magnetic Circuit, 486
Magnetic Leakage, 383
Magnetisation of Iron, Report of B. A. Com-
mittee, 313

Maidstone and Electric Treatment of Sewage,
21

Mains, Electric, Explode, 222

Managers, Electrical, 271

Manchester Technical School, Present to, 221

Mansfield, G. W., Electric Railways, 196,
214

Manville, E., Series Electrical Traction, 238

Marriage of Mr. Johnston, 481

Maxim-Weston Company, Meetings, etc., 489

Medical Electricity, Institute of, 241

Melbourne Exhibition Lighting, K. L. Mur-
ray, 392, 412, 436

Memorial to James Watt, 501

Mercury, Separation of, from Copper, 122

METERS, ELECTRIC: The Brush, 273; Gregory's
Radiation, 378; Paris Prize Competition, 21;
Reckenzaun's, 83

Metropolitan Company's Meetings, 500, 509

Metropolitan Company's Provisional Orders,
81, 101, 121

Metropolitan Company's Work, Progress of,
169

Mica Conduits, 441

Mica as an Insulator, 481

Milk Preservation, 21

Mine Lighting, 201, 241

Mining Conference, 201

Mining and Electricity, Normanton Colliery,
401

Mining and Electricity at Wigan Show, 83

Mining and Power Transmission, A. T. Snell,
294

Monaco, Prince of, and Deep Sea Fishing, 304

Monte Video Telephone Company, Meetings,
etc., 320, 340

Moral of the Tale, The, 490

Morocco, Cable for, 381

MOTORS, ELECTRIC—

Alternate, F. J. Patten, 287
Business in, 265, 282, 443
C & C for Ventilating, 402, 421
for Cancelling Money, 341
Constant Speed for Tramways, 324
for Farm Work, 401
A Half-way Measure, 261
for Mining, 284, 401
Regulator for, 421
for Sewing Machines, 281
Show Your, 282
Statter's, 193
Tesla's Self-Starting, 48
to the Front at Davis and Sons, 223
to the Rescue, 64
for Turntables, 121, 403
and Type Setting, 204
for Ventilators, 402, 421, 482
Westinghouse Alternate, 123

Motors, Pneumatic, for New South Wales, 41

Motors, Wave, 142

Municipal Control of Lighting, 462

Muscles, Electric Stimulation of, 342

Museums, Prof. Flower, 206, 210

N.

National Electric Light Association, Niagara
Meeting, 155, 177, 196

National Telephone Company's Meetings, etc.,
39, 259

Neale, F. W., Death of, 363

Newport Pagnell in Darkness, 221

New Soldering Fluid, 501

New South Wales and Pneumatic Motors, 41

New York Exhibition, 122, 141, 421

New York Notes, 153, 175, 194, 212, 234, 252,
266, 292, 312, 332, 351, 371, 388, 408, 432,
458, 473, 486

New Zealand, Power Transmission in, 477

New Zealand, San Francisco Cable, 161

Niagara, Utilisation of, 262

Normanton Colliery Plant, 401

North Metropolitan Tramways and Electric
Traction, 264, 421, 463

O.

OBITUARY NOTICES: Gooch, Sir D., 311;
Gray, J. K., 423; Hall, W., 421; Joule,
Dr., 311; Neale, F. W., 363; Pacinotti,
L., 463; Torrington, Viscount, 322

Ocean Depths, 267

Oil-Filter, New, 63

Okonite Company's Progress, 101

Okonite Wire, 465

Omnibus, Electric, 1, 21

Optics, Geometrical, S. P. Thompson, 499

"Out for an Airing," 30

P.

Pacinotti, L., Death of, 463

Paget's Transformer, 429

Paintings and the Electric Light, 363

Palace of Industry, The, 22

Paris, Conduits, 201

Paris Conferences (Walking), 22

Paris Congress, 143, 164, 186

PARIS EXHIBITION: Awards, 272, 281, 301;
Closing of, 341; Crompton's Exhibits, 93,

167; Edison Plant Purchased by Municipal

Council, 402; Elliott Bro.'s Exhibits, 146;

English Exhibits, 92; Globe Company's

Exhibits, 166; Lighting of, 61; President

Carnot's Visit, 61; Representatives at, 9,

21; Timmis's Block Signal System, 105

Paris, Testing Laboratory for, 184

Paris Theatres, 462

Paris in Two Hours, 65

Parson's New Works, 142, 202, 321

Patents, Electrical, Bought up by Belgians, 281

Patents, Jordan's Book on, 321

Patents, Leading Article on, 11

Patents, List of, 20, 40, 60, 80, 100, 120, 140,

160, 180, 200, 220, 240, 260, 280, 300, 320,

340, 360, 380, 400, 420, 440, 460, 480, 500,

512

Pattern, F. J., Alternate Motors, 287

Peddle's Improvements in Railway Signalling,
45, 321, 369

"Peral" Submarine Boat, 224, 461

Perrin and Masson's Arc Lamp, 29

Perry, Prof., Address to Junior Engineering
Society, 306, 310

Perry, Prof., Twisted Strips, 379

Personal, 21, 101, 121, 141, 241, 261, 321, 341,
342, 361

Phantom Ship, A, 165

Phillips, S. E., Diamagnetism, 46, 67

Phoenix Works, 284

Phonograph, Accumulators for Use with, 141

Photography, Instantaneous, 424

Photometer, New, 62

Photometry, W. J. Didden's Book on, 81

PHYSICAL SOCIETY: Bidwell, Electrification

of a Steam Jet, 499; Bottomley, Expansion

of Wires, 19; Burton, Theory of Errors,

379; Carus-Wilson, Steel, its Behaviour

under Stress, 499; Clayden, Photos of

Lightning, 19; Enright, Contact of Gases

and Liquids, 379, 418; Gregory, A Radia-

tion Meter, 378; Driving Tuning-Forks,

378; Perry, Twisted Strips 379; Thompson,

S. P., Geometrical Optics, 499; Tomlinson,

Resistance of Annealed Iron, 418

Piccadilly Circus, Mains at, 502

Pilot Car for Trains, 223

Pipe-Lighter, Electric, 422

Pneumatic Motors for New South Wales, 41

Police, Electric Signals for, 61

Police Signals, Visual, 65

Portelectric Express System, 184

Postmaster-General v. Great Western Rail-
way, 138

Post Office, General, its Surplus, 163

Post Office Telephones in the North, 262

Post Office Telephones in South Wales, 255,
264

Postal Orders, Telegraphing them, 164, 302

Power Transmission and Mining, A. T. Snell,
294

Power Transmission in New Zealand, 477

Preece, W. H., Dangers of Electricity, 244,
250

Preece, W. H., Telephoning between London
and Paris, 249

Prescott, G. B., Accumulator Lighting, 395,
416

Prices, Increased, 264
Printing Telegraph, Column, 283
Private Bills, Time for Depositing, 302
Progress in Electricity, A Decade of, 104
Progress, Report of, 168, 204, 223, 243
Provisional Order for South London Abandoned, 81, 101
Provisional Order Bills, 24, 42, 65, 102, 121, 141
Provisional Orders and Local Authorities, 25, 42, 44, 64, 101, 121, 122, 123, 141, 142, 143, 161, 163, 182, 185, 201, 221, 222, 241, 261, 263, 281, 283, 284, 301, 302, 321, 324, 341, 343, 361, 381, 382, 383, 401, 403, 421, 423, 430, 441, 442, 443, 461, 462, 463, 464, 481, 482, 483, 484
Provisional Orders, Number Applied for, 381, 402, 430, 457
Provisional Orders, Parliamentary Proceedings, 25
Pullman Car Company and Electric Railways, 441

Q.

Quadruplex Telegraphy in Australia, 101
Queen Victoria-street, 282
Quite a Stretch, 501

R.

Racing and Telegraphy, 81
Radiation Meter, W. G. Gregory, 378
Rails, Electric Welding of, 202, 452
Railway Brake, Timmis and Forbes's, 154, 463, 484
Railway Signalling, Electricity Applied to, 301
Railway Signalling, Peddie's Improvements in, 45, 321, 369
Railway Signals, Timmis's Block System, 105, 302
Railway Station Telegraph Offices, 192
Railway Switches Operated by Electricity, 183
Railway, Underground, at Edinburgh, 422
Railways and Electricity, 121
Railways, Increasing the Traction on, 203, 322
Railways, A Pilot Car for, 223
Railways, Underground, Electric Traction for, 85

RAILWAYS, ELECTRIC (see also TRAMWAYS)—
in America, New, 361, 441, 461
American Trust, 41
Bentley-Knight Company's System, 57, 76, 121
between Beverly and Danvers, U.S., 355
Blair and Blickensderfer's System, 109
at Boston (U.S.), 121, 421
at Bremen, 481
at Buda Pesth, 141, 422
at Cincinnati, 101
in Cleveland (U.S.), 64
Conditions of Success, T. C. Barr, 373
Convention at Minneapolis, 121
Daft's, in New York, 64
at Des Moines (U.S.), 124
for Eastbourne, 161
at Greenfield, Cost of, 461
for India, 103, 125
in Kansas, 49
at Lanark, 161
at Lichterfeld, 321
at Liverpool, 61
by G. W. Mansfield, 196, 214
at Omaha (U.S.), 81
at Peoria (Illinois), 21
in Philadelphia, 478
at Pittsburgh, 1
Portelectric System, 184
at Richmond (U.S.), 364
at Ryde (I. of W.), 221
Safety Overhead Guard Wire, 368
at Salt Lake City, 202
Sand Distributor for, 442
Short's, 23
Southwark Subway, 124, 301, 462
at Sunbury (U.S.), 162
Underground for London, 403, 425, 502
Underground for New York, 81
at Vevey, 201
Weems's Rapid Transit, 61, 115, 145, 183, 203, 281
at Wichita (U.S.), 81

Ransomes' Expansion Gear, 349

Ransomes, Sims, and Jefferies, Work of, 361
Rapid Transit System, Weems, 61, 115, 145, 183, 203, 281
Reading Lamp, Electric, 3, 31, 41, 187
Reckenzaun's Meter, 83
Reed, C. J., Form of Filaments, 496
Reflector, Rathbone's, 451, 473
Registering Machine, Electric, 102
Resistance Box and Wheatstone Bridge, 449
Reuter's Telegram Co., Meetings, etc., 259
Reviews of Books (see LITERATURE)
Rhine, The, Utilisation of, 242
Rhodes, B., Wire for Constant Current Circuits, 179
Roller Bearings, 462
Roofing, Wire-wove, 281
Rotary Engine, Kiehl's, 202
Russian Telegraphs, 341
Rysselberghe's System in China, 301

S.

St. James's Co.'s Work, Progress of, 169
Sales of Plant, 161, 181, 221, 281, 321, 341
Sand Distributor, A, 442
Sardinia-street Station, 483
Savoy Hotel, The, 251
Sawyer-Mann Lamps, Demand for, 421
Schmidt-Douglas Co., Liquidation of, 181
School of Electrical Engineering, 101, 262
Schuster, A., Passage of Electricity through Gases, 258
Scientific American, Spanish Edition, 501
Scotch Corporations and Electric Lighting, 443
Scott and Co.'s Exhibits at Birmingham, 235, 314
Screws, Standard Types of, 75
Scribner's Monthly, 161
Search Lights for Advertising, 161
Search Lights for the Navy, Alterations in, 341
Searing and Hoffman, Westinghouse's Dynamo, 126
Semi-Incandescent Lamp, Pieper's, 163
Series Traction, E. Manville, 238
Series Traction Company, Reconstruction of, 1
Sewage, Electric Treatment of, 21, 144, 182
Sewage, Pumping, 501
Sewage Purification, W. Webster, 246, 291
Sewing Machines Driven by Motors, 281
Shanghai, Contract for Fittings, 81
Shaping Machine, Double, 381
Shares, Electric, Booming, 263, 281
Shaw, A. J., Mechanical Details of Electrical Machinery, 132
Sheffield and Electroplating, 433
Shell Hoist, Electric, 61
Ship Lighting, 1, 21, 101, 181, 198, 341, 362
Short's Electric Railway, 23
Signalling, Electric, Peddie's Improvements in, 45, 321, 369
Signalling, Electric, Timmis's System, 105, 302
Signalling on Railways, Electricity Applied to, 301
Silcock, E. L., Notes on Electric Lighting, 35, 51
Silvertown, Strike at, 241, 264, 292, 431, 471
Slattery, Speech at Chicago Electrical Club, 158
Smith, M. H., Underground Railways, 85
Smithfield Show, Engines at, 466
Snell, A. T., Power Transmission and Mining, 284
Solar Radiation and Electricity, 342
Soldering Flux, 436
Soldering Fluid, New, 501
Soup-plates, Electric, 221
South London Provisional Order Abandoned, 81
South of England Telephone Company, Meetings of, 19, 380
Southend, Electric Engine for, 181
Southwark Electric Subway, 124, 301, 462
Spanish Exhibition, 362
Sprinkler, An Automatic, for Fires, 223
Stamp, An Electric, 341, 481
Standardising Laboratory, Proposed, 64, 149
Staple, New Insulating, 62
Station Indicator, 422
Statue to Dr. Joule, 501
Steam-Engine Expansion Gear, Ransomes', 349
Steam-Gauge, Julien's Electric Alarm, 192
Steam Jet, Electrification of, S. Bidwell, 499
Steed v. Appleton, 482
Steel Under Stress, C. H. Carus-Wilson, 499
Steinmetz, C., Transformers, 255

Storage System of Lighting, The, 164, 202
Street Lamps in Birmingham, 461
Strikes, The, 163, 241, 264, 281, 290, 292, 431, 471
Stroud, H., E.M.F. of Two Portions of Same Metal, 237
Submarine Boat, The "Gorbet," 302
Submarine Boat, The "Peral," 224, 461
SUBWAYS: and the County Council, 403; for London, 462, 464, 488; Ventilation of, 342; between the Strand and Holborn, 341
Sugar Fraud, The, 81
Sumpner, W. E., Alternate Currents, 406
Sunbeam Lamps, 241, 261
Swallows Killed by Electricity, 183
Swan Shares, Rise in, 263, 281, 361
Swan United Company, Meetings, etc., 379, 418
Swinburne, J., Transformers, 226
Switch, Sprague's Tramcar, 4
Switches, Brush Company's, 286

T.

Tabulating System, Electric, 205
Tachyscope, Electric, 424
Tanning, Electric Process of, 343, 364, 441
Tatham's Cables, 21, 49
Taunton Electric Light Company, Meetings, etc., 345, 399
Technical Attachés, 481
Technics and Language, 383
Teeth, Extraction of, and Electricity, 222
Telegrams, Late, 162
Telegraph Clerks, Combination Among, 401
Telegraph Construction Company's Meetings, etc., 39, 58
Telegraph Manufacturing Company's Cables, 203
TELEGRAPH: The Column Printing, 283, 489; a Cut-Off, 202; Cyphers, Oriental, 385; for Engine-Room, Willis's, 147; Offices, Country, 23
Telegraphic Tape Machine, New, 523
Telegraphing Plans, 161
Telemeter, The, Uses of, 142

TELEPHONE—

The Amalgamation, 21
in America, Long-Distance Lines, 422
Boxes, Coin-Feed, 41
at Buenos Ayres, Submarine Line, 462
Company of Austria, Meetings, etc., 280
at Coventry, 4, 102
between Dundee and Glasgow, 201
Electrics, 165
in France, 24, 184, 202, 401
in Germany, Statistics of, 321, 401
Goulding's Adjustable Transmitter, 201
and the Government, 23
Induction, J. J. Carty, 447
in Italy, 441
Lecture on, A. Coleman, 364
between London and Paris, W. H. Preece, 249
in Manchester, 441
in Minneapolis, 381
Mix and Genest's Portable, 303
in Newcastle-on-Tyne, 161
for Newspapers, 481
in the North of England, 262
in Paris, Confiscation by Government, 184, 202, 401
Patents, United Co. v. Norton, 241
between Portland and Buffalo (U.S.), 321
at Portsmouth and Winchester, 441
in Puerto Rico, 221
the "Pulsion," 463
Rather Tall, 342
Rysselberghe's System in China, 301
in Scotland, 462
in the South of England, 421
South of England Company's Meetings, 19
in South Wales, Post Office wires, 255, 264
and Theatres, 161
Tickets, 75
and Torpedo Boats, 221
in Totquay, 263
Vibrations Made Visible, 43
between Vienna and Prague, 262
in the West of England, 101, 183, 201, 263, 264
Wire, Non-Inductive, 42
Wire Protector, 373
Wires and Carriages, 61
in Worcester, 302

Telpher Line at Alexandra Palace, 122
Telpher System for Brechin, 5

Temperature Indicator, Electric, 62
Tesla's Self-Starting Motor, 48
Thames Steamers, Lighting of, 198
Theatre Lighting, 62, 181, 285, 301, 341, 461, 462
Theatrophone, The, 161
Thompson, S. P., Geometrical Optics, 499
Thompson, S. P., Jobbery in Electric Lighting, 322, 350
Thompson and Rew, Dissolution of Partnership, 461
Thomson, Sir W., Electrification of Air by Flame, 346
Thomson-Houston and Fort Wayne Jenney Co.'s Amalgamation, 181
Thomson-Houston Co., Increase of Stock, 341
Thomson-Houston Motor Business, 443
Thunderstorms, 403
Timmis's System of Electric Signalling, 105, 302
Timmis and Forbes's Railway Brake, 154, 463, 484
Tomlinson, H., Resistance of Annealed Iron, 418
Torpedo Boat, Submarine, 224
Torpedo, Electric, 1, 61
Torrington, Viscount, Death of, 322
Traction Power Increased by Electricity, 203, 322
Trades Union of Electric Workmen, 281
Train Lighting, A. S. Brown, 88
Train Lighting, 201, 241, 402, 481
Trains, Electric Pilot Car for, 223
Trains, Telegraphing to, 181
Tramways, Steam, at Neuilly, 401

TRAMWAYS AND TRAMCARS ELECTRIC (see also RAILWAYS, ELECTRIC)—
Accumulator Cars in America, 5, 57, 76, 102, 155, 181, 209, 281, 282, 355, 478, 484
in America, Success of, 144
in Australia, 62, 201
at Barking, Accident on, 63
at Beverly and Danvers, 484
in Birmingham, 161, 322, 342, 365, 384
for Bisley, 441
for Bombay, 441
in Boston (U.S.), 449
Brush Work in Spain, 182, 401
in Brussels, 401
Constant Speed Motors for, 324
Electric Traction Company's System, 421
for Florence, 223, 301, 361
for Germany, 281
and Horse-Cars, 483
in Italy, 441, 462
Julien's System, 102, 174, 209, 281, 363
and London County Council, 122
for Madrid, 381
in Melbourne, 201
for Morecambe, 61, 143
New Car Switch, 4
on North Metropolitan Tramways, 264, 421, 463
in Paris, 41
in Philadelphia, 478
for Plymouth, 381
Repairs Item, The, 2
in St. Louis and Kansas, 262
in Savannah (Galveston), 321
Series System, E. Manville, 238

TRAMWAYS AND TRAMCARS (continued):—
Thomson-Houston System, 321, 384
in Washington, 181
Westinghouse System, 1

TRANSFORMERS: Acheson's Calelectric, 125;
Losses by Foucault Currents, 341; Notes on,
C. Steinmetz, 255; Paget's, 429; Precau-
tions when Using, K. Hedges, 236; by J.
Swinburne, 226

Trees and Wires, New Insulators for, 182
Trumpet, Electric, 2
Truro, Electric Alarms for, 121
Tuning-Forks, Electrical Driving of, 378
Turntables, Worked by Motors, 121, 403
Twisted Strips, Prof. Perry, 379
Type Setting by Motor, 204.

U.

UNDERGROUND WIRES: At Ascot, 261; in
Berlin, 382, 461; Brooks's System, 101,
231; Callender, St. James's, and Metro-
politan Companies' Systems, 169; in
Chelmsford, 402; Crompton's Conduits,
201; in Exeter, 261; Strand-Holborn, Sub-
way for, 341

Union Electric Car Company's System, 355
United Electrical Engineering Company,
Pamphlet Issued by, 64, 192
United River Plate Telephone Company,
Meetings, etc., 139
UNITED TELEPHONE COMPANY: v. Ahern and
Co., 18; v. Liversedge and Brierley, 22;
Meetings of, 38; v. Norton, 241; v. Smith,
362
Units, Electric, American Definition of, 123
Unwin, W. C., Old Students' Dinner, 339
Uranium in Cornwall, 341
Uruguay Tramways, 202

V.

Van, Electric, Proposed, 63
Verity's Electric Fittings, 10, 13, 23
Victor Turbine, Award to, 321
Vienna Central Station, Tests at, 391
Vienna, Luminous Fountains at, 461
Volta's House, 41
Voltmeters, Cardew's, 383
Voltmeter, Pocket, 262
Vote Recorder, Electric, 42

W.

Waggonettes, Electric, 102
Walker and Co., Change of Address, 421
Walker and Hall's Works, Festivities at, 433
Walker, S. F., Electricity in our Homes, 251
Walker Engineering Laboratory, 383
War Office Contracts, 2
Watches, Non-Magnetic, 161, 502
Water Colours and the Electric Light, 363
Water Gas, 21
Water Power, Utilising, 42, 61, 182, 501
Water Railway, 65

Watt, A., Electrolysis of Bismuth Salts, 12,
26, 46, 68
Watt, James, Memorial to, 501
Wave Motors, 142
Weathercock and Barometer, 190
Webber, General, Chelsea Lighting, 272
Webster, W., Sewage Purification, 246, 291
Weems's Rapid Transit System, 61, 115, 145,
183, 203, 281
Welding, Electric, 1, 142, 461, 463
Welding, Electric, for Rails, 202, 452
West Coast of America Telegraph Company's
Meetings, etc., 40
Western and Brazilian Telegraph Company,
Meetings, etc., 380
Western Union Company and the American
Government, 82
West India Telegraph Company, Meetings,
etc., 340, 380, 399
West India Cables, 501
WESTINGHOUSE: Alternate Motor, 123; Con-
solidation, 41, 82; Dynamo, Variation of
E.M.F. in, 126; Purchases of Copper, 401;
Works in London, 241, 282
Westminster Electric Supply Company, Meet-
ings, etc., 480
Wigan Agricultural Show, 83
Willis's Engine-Room Telegraph, 147
Wilson, C. H. Carus, Steel Under Stress, 499
Wine, Electrification of, 301
Wire, Bronze Telephone, 501
Wire-wove Roofing, 281
Wires, Expansion of, J. T. Bottomley, 19

WIRES, OVERHEAD: Board of Trade Rules,
48, 81, 156, 411; Danger of, 22, 382, 450;
in Glasgow, 465; in London, Fall of, 423;
London County Council Bill, 462, 488; in
New York, 301, 442; and Trees, New Insu-
lators for, 182; in Wandsworth, 321

WIRES, UNDERGROUND: At Ascot, 261; in
Berlin, 382, 461; Brooks's System, 101,
231; Callender, St. James's, and Metro-
politan Companies' System, 169; Chelms-
ford, 402; Crompton's Conduits, 201; in
Exeter, 261; and London County Council,
381, 403; Mica for, 441; Strand-Holborn,
Subway for, 341

Wiring Calculations, G. T. Evans, 91.
Wiring Tables, Woodhouse and Rawson's, 361
Woking Electric Company's Works, 261
Wolverhampton, Electric Construction Com-
pany's Works, 385
Wonders, Age of, 309
Wood Casings, 162
Woodhouse and Rawson, 71, 79, 361, 400, 423
Workshops, Electric Signals for, 422
Writing Telegraph, The, 221

Y.

York Tramways, 164
Yorkshire, South, Electricity in, 409

Z.

Zinc, Atomic Weight of, 44

THE
ELECTRICAL ENGINEER.

No. 1, Vol. IV.

LONDON, JULY 5, 1889.

PRICE 3d.

NOTES.

Sale of Plant.—The sale by auction of manufacturing plant at Birmingham, by Messrs. Wheatley Kirk, Price, and Goulty, advertised last week, continues to-day, Friday.

Lisbon.—A new building is proposed for the telegraph office at Lisbon. Plans may be sent in until October 28, and prizes will be offered as first and second premiums. Particulars can be obtained of Mr. Alan Danvers, Lisbon.

The Electrical and Mechanical Exhibition in Edinburgh.—An application has been made to the Corporation of Edinburgh for the use of the East Meadows as the most convenient site for the proposed Electrical Exhibition to be held next year.

Electric Fishing.—The latest, the very latest, application of the motor is to salmon fishing. A small motor worked with a pocket battery is to be used to run the reel of a salmon fishing-rod, and play the unruly inhabitant of the water by motor force instead of by hand.

The Electric Omnibus.—Another run was made by Ward's electrical street car on Tuesday morning through many crowded thoroughfares. The omnibus ran through the City from Islington to the depot, James-street, Haymarket, at a speed in excess of $8\frac{1}{2}$ miles per hour.

Telpherage at Birmingham.—The executive of the forthcoming exhibition at Bingley Hall, Birmingham, have instructed the United Electrical Engineering Company, Limited, of Westminster, to furnish locomotive, car, and equipment for a telpher line to be erected within the building.

Electric Light on the Seine Boats.—The express steamboats on the Seine running the river service to the Paris Exhibition, have been lighted for some time with the electric light. A small steam-engine of 4 or 5 h.p. works a Breguet dynamo producing current for 17 incandescent lamps, which light the engine-room, saloon, and the signals.

Alternate Current Electric Cars.—The Westinghouse Company expect to have their electric cars ready by the autumn. Tesla motors will be used, with overhead wires working with alternate currents. The absence of commutators will enable high-pressure electricity to be used, and the introduction of the system is looked forward to with considerable interest.

Zurich.—The central installation for Zurich is likely to prove one of the most interesting ones now in view of settlement. The following firms are entering for the competition: Siemens and Halske, Berlin; Crompton and Co., Chelmsford; Thomson-Houston International Electric Company, Hamburg; L. and J. Séé, Lille; Ganz and Co., Buda-Pesth; and Schuckert and Co., Nürnberg.

A Comprehensive Electric Company.—A company has been organised for the purpose of supplying the village of Lakeside, Minnesota, U.S., with electricity, gas, and water, and building and operating works; also to deal in pumps, hydrants, to do house-plumbing, gasfitting, and to buy, own, sell, and mortgage real estate, etc. Lakeside will soon be fitted, and, in fact, run altogether by the electric company.

Welding Barrel Hoops.—Electrical welding has given quite an impetus to many industries in the States. At Worcester, Mass., the makers of a new hoop, says the *Electrical World*, are using the process and find the saving over the ordinary mode immense, as a hoop can now be welded in two seconds. The hoop itself is of a corrugated steel, for use on flour barrels, and four steel hoops now take the place of 10 wooden ones.

Electric Torpedo.—The Edison-Sims torpedo, formerly known as the Sims, was recently tested at the proving ground at Wellett's Point, Long Island, U.S., and although only a dock trial was made, it was eminently successful. By the introduction of an electric motor, fed by a dynamo on shore through two wires, which also serve to guide and steer the projectile, a speed of at least 20 knots an hour has been reached. The range of the torpedo has been doubled.

The Residues of Bichromate Cells.—M. G. Fournier has discovered a use for the residues of bichromate cells, which, if found of value commercially, will cheapen these handy batteries. He has obtained in crystallised sulphate of potash (K^2SO^4), oxide of zinc (ZnO), and chromic oxide (Cr^2O^3), and other by-products, materials for the manufacture of artificial colours, some of them of great beauty, and all, we are informed, of remarkable durability.

Large Electric Railway for Pittsburgh.—The Sprague Electric Railway and Motor Company recently closed a contract for electric railway apparatus at Pittsburgh for 25 cars, with complete station equipment and overhead line system, to be operated by the Federal-street and Pleasant Valley Railroad Company. The road will run through the most important streets of the city, and the overhead work will be of the lightest description. Iron poles will be used, and every improvement will be utilised on this line.

Rotherhithe.—At the last meeting, the clerk of the Rotherhithe Vestry reported that Mr. M. Boyle, of the Board of Trade, had written as to the settlement of a schedule of streets within which the London Electric Supply Corporations are to lay mains in this parish. The General Purposes Committee reported that they had agreed with the suggestions of the company that Lower road and Union-road should be included in the schedule, and suggested that Rotherhithe-street be added, which was agreed to.

New Series Traction Company.—The Series Traction Syndicate, whose successful practical exhibition of

their system of tramway working at Northfleet we recently described, has been reconstructed in a larger form as a company. The public, we understand, will not be appealed to, the money being found privately. Negotiations are pending with several leading tramway and railway companies, and the introduction of the series system on a considerable scale may be expected as a result of the formation of this company.

The Heisler System.—Plenty of work is reported, according to the *American Engineer*, for the Heisler Electric Light Company. A new station at Belton, Texas, has just been started, and central station plants at Port Arthur, Ontario, and Montrose, Colorado, are also being started. Of all the systems of lighting which have not yet found their legs the Heisler will probably prove the strongest infant. Mr. Heisler, we hear, expects to leave America for Paris in a few days, to give personal attention to his exhibit, and to make arrangements for the working of the system in Europe.

"The Steamship."—The first number of a new monthly journal under this name, published at Custom House-chambers, Leith, has been sent to us, and appears to be a very useful paper for its peculiar field. A special feature is to be made of electrical items, and an article on "Electric Lighting" by G. J. Burns, B.Sc., assistant surveyor to the R. E. department, is given in this number, together with an illustrated article on Mr. Campbell-Swinton's bells, and a column of electrical notes, bearing on marine subjects. We wish this well got up and comprehensive paper the success it evidently deserves.

The Electric Light in Barnet Church.—On Monday evening a trial of the electric light took place in the Parish Church, Barnet. Messrs. H. F. Joel and Co., at the request of the rector and churchwardens, temporarily fitted up an arc lamp in the chancel, and after the service the lamp was lighted. The beautiful chancel of the church was displayed to advantage, and, so far as that portion of the building was concerned, the experiment was considered successful. Several more lamps will no doubt be added in the event of its being decided to substitute electric light for gas.

City of London.—The clerk of the Commissioners of Sewers laid before the court a notice of the Anglo-American Erush Electric Light Corporation of their intention to apply to the Board of Trade for a provisional order to supply electricity within the City of London, and asking for the Commissioners' consent thereto; also a notice of the Metropolitan Electric Supply Company of their intention to apply to the Board of Trade for a provisional order to supply electricity within the City, and of Laing, Wharton, and Down Construction Syndicate to the like effect. These letters were referred to the Streets Committee.

Electric Bleaching.—Other fields than arc lamps are now employing the inventive genius of our electricians. Says the *Gas World*: Mr. Charles Lever, of Altrincham, a member of the Electrical Societies of England, France, and America, son of Mr. Ellis Lever, has succeeded in producing, by means of electricity, direct from natural brine, bleaching powder, caustic soda, and a solution to be used in bleaching the finest and most delicate fabrics. This discovery is likely to have the effect of revolutionising the manufacture of bleaching powder and the bleaching industry generally. The process has been protected, and will be rapidly developed on a practical scale.

Electric Trumpet.—A trumpet producing its musical note by the vibration of a circular steel membrane by

means of electricity, has been invented by Captain Zigang, of the 30th infantry, in garrison at Domfront, Orne, France. The vibrator has a small soft iron armature, which vibrates under the influence of an electro-magnet, with make and break platinum contact, and this, covered in by a copper resonator, produces a trumpet-like note. The strength of the sound can be varied by regulating the contact, and with several instruments connected by a commutator, a bugle-call or musical airs can be played. The electric trumpet is made by M. Basse-Crosse, 92, Rue de Bondy, Paris, and is supplied in four sizes.

Automatic Accumulator Station in France.—Electric light has been recently introduced into the town of Saint-Hilaire du Harcouet, on the coast of France. The station is situated at Varoux, some three miles off, in order to utilise a waterfall for the motive power. Two coupled turbines are used, which run a Thury dynamo, giving 600 volts and 17 amperes. Sets of accumulators are placed at the four corners of the town, and are charged for a period of 16 hours. At night everyone goes to bed at the station, and the illuminating and extinction of the public lamps is effected by the mayor's clock, which is arranged to connect and cut off the current at certain hours. A similar system was adopted at St. Etienne in 1883, where a waterfall at Furens was utilised.

Electric Light for Wolverhampton.—The registration has been announced of the Wolverhampton Electric Light and Power Company for the production, supply, storage, and use of electricity, or other force in that town with a capital of £50,000 in £10 shares. Messrs. Elwell-Parker were known to be moving in the matter of the introduction of electric lighting into their own town, and the manner in which the scheme has been organised will probably be productive of the best results in the distribution of electric light in Wolverhampton. The company is evidently in considerable favour locally, the first subscribers to the scheme being no less than 23, all residents of Wolverhampton or the neighbourhood, and we hope to hear of the speedy getting to practical work of the new undertaking.

War Office Contracts.—An important question was asked in the House of Commons last Monday which it would be well for our English manufacturers to watch. Mr. H. Vincent asked the Secretary of State for War whether he was satisfied that the Director of Contracts could not have placed within the United Kingdom, with due regard to the public service, the War Office contracts concluded with foreigners during the past financial year for butt ends, silk cloth, electric apparatus, and projectiles; among these £3,683 was for electric light and telephone apparatus. Mr. E. Stanhope stated that these contracts could not have been placed within the United Kingdom. As regards the electric light and telephonic apparatus, certain articles of foreign manufacture (such as Ader's telephones, etc.) were required, and they were bought where they are made.

The Repairs Item in Electric Traction.—The continued spread of the employment of electric motors on street tramways, and the necessity for the working of these pieces of moving machinery by engineers who are not electricians, has led these gentlemen to notice with considerable alarm the large item for repair or renewal of armatures. Electricians may make allowances for the so-called delicate nature of the armature, and dilute on the difficulty of repair, but for practical work on tram lines, delicacy must be

abrogated to instruments, and is out of place in motors. In view of the serious question of the high price of repairs, some of the street railway companies in America have proposed the formation of an association amongst electric car companies to combat the high charges now made by the electric supply companies for repairs or renewals, and also to consider the question of greater wearing strength of the moving parts of the motors in accordance with acknowledged railway practice.

German Telegraph Works in Difficulties.—

According to *Kuhlow's Gazette*, an extraordinary state of affairs has been disclosed with regard to the Hannover KautschukGuttapercha und Telegraphen-Werke. While the financial year 1887 closed with a net profit of 61,296 marks, with which a dividend of 5 per cent. was paid, the year 1888 closed with a loss of 474,896 marks, so that after deducting the reserve of 17,841 marks, the balance shows a loss of 474,869 marks on a share capital of 900,000 marks. At the general meeting held on April 8 last, the shareholders were informed that the directors (who have since resigned) had shown a gross profit on the half-year's working to July 1, 1888, of 114,166 marks; the annual report prepared by the new directors with the assistance of their predecessors shows a deficiency of almost half the share capital. In order to throw some light upon this almost incredible difference, on the suggestion of the supervision committee, which had not succeeded in clearing up the matter, a further committee was elected, and the latter is to present its report at the forthcoming general meeting.

The Ideal Dynamo.—In commenting on the recent advances in armature construction, especially as regards fireproof qualities, Mr. H. Franklin Watts, writing to the *Electrical World* says: "The ideal dynamo of the future contains no cotton at all, asbestos, mica, porcelain, etc., being used throughout. The conductors will stand a temperature of 500 F., and the insulation still remain intact. The armature-coils will be fastened to the core as securely as the driving-pulley is fastened to the shaft, for the power applied to both is precisely the same. There is no more excuse for ever burning out an armature than for an engine to knock out its cylinder head, and yet this continues to be repeated under our very noses; and with all the ingenuity of electricians and their infinite knowledge of 'Foucault currents' and 'characteristic curves,' they have never yet investigated this simple matter—the mechanical driving of armature coils." There is a great deal to be said for such an ideal of construction. It would be more costly, but it would probably only be necessary for a single maker to advertise such a dynamo or motor for a rush to take place for such machines, and a similar method of construction to be widely adopted.

The Burton Electric Heater.—Some interesting and highly successful tests were made recently with the Burton electric heaters in a house next door to the *Richmond State* offices. Thirty heaters were arranged on the large floor to represent their relative position on two railway cars, allowing 15 to each car. In another part of the room was a single heater on which the inventor proposed to do some cooking. The current for the tests was supplied by the power circuit of 220 volts. In order to show the different degrees of heating one set of heaters was connected in series of three and the others in multiple. In addition to the heaters, a number of incandescent lamps were suspended from the ceiling of the room, which, by turning a switch, could be made to glow or be cut out at the will of the operator. The test was intended for the

benefit of the shareholders of the Burton Electric Company, who were invited to witness the practical operation of the heaters. Dr. Burton had his cooking apparatus in operation, and on it he boiled water and distributed among the visitors a number of eggs, boiled as nicely as could have been done on a kitchen range. The shareholders announced themselves more than pleased with the operation of the Burton electric heaters, and enthusiastically confident of its future usefulness.

An Automatic Electric Reading-Lamp.—The latest and most ingenious application of the penny-in-the-slot automatic apparatus is the adaptation of this principle to the supply of electric light in the shape of reading-lamps for railway carriages, omnibuses, tramcars, etc. The lamp in question has been patented by a Leeds firm. The lamp, as originally patented, consists of a clockwork apparatus contained in a box 5in. by 5in. and 3in., and by introducing a penny into the top of the machine, and subsequently pressing a knob, the mechanism is set in motion and an electric light obtained, which, after burning for half an hour, is automatically extinguished. The lamp can, moreover, be extinguished at will by pressing a second knob. This lamp will, it is stated, in the course of a few days, be in use on the Great Western Railway. The lamps are lighted from an accumulator, which, placed in any of the compartments of a carriage, will supply with electricity the whole of the lamps in the carriage. The accumulator can thus be changed at any station without interfering with the light. The accumulators will be charged with a 40 hours' supply. A remarkable feature is that should the supply of electricity fail, or should the lamp fail to act, the coin deposited is automatically returned to the operator. The lamps will be fixed under the hat-rail of the carriages, and by this means passengers can lean back and read at their ease.

Kingston and District.—At the last meeting of the Wimbledon Local Board, a proposal was submitted by a company (the name of which did not transpire) to supply electric lighting to a large district, embracing Wandsworth, Wimbledon, New Malden, Surbiton, Kingston, Ham, Richmond, Mortlake, Barnes, Kew, and Putney. The capital of the concern is £500,000 (nominal). Contracts will, after the provisional orders have been obtained, be entered into with responsible firms to lay underground mains throughout the district, capable of supplying 100,000 lamps from three centres at Kingston, Mortlake, and Wandsworth respectively, and to supply generating plant for 50,000 lamps at once. The contract price is to be £400,000. The contractors will also work the stations and supply the current required, not being less than 50,000 lamps, for £1 per lamp per annum. The revenue from 50,000 lamps—the minimum supply—is estimated, at 4½d. per unit (which is stated to be equivalent to gas at 3s. 6d. to 3s. 9d. per 1,000 cubic feet), to produce rather more than £80,000 per annum, leaving a surplus of £30,000 per annum for the company. After providing for the expenses of collection and a sinking fund, there will remain, even from the rental of 50,000 lamps, a surplus capable of paying a dividend of from 4½ to 5 per cent. These figures are based upon supplying a population of about 210,000. Some discussion was entered into as to the possibility of realising these figures in practice, and the communication was referred to the Electric Lighting Committee. It is stated that the Board are also applying for a license to enable them to light the district under their jurisdiction by means of electricity.

New Electric Car Switch.—A new electric switch for street railway work has just been brought out by the Sprague Electric Railway and Motor Company, which certainly seems to commend itself for practical use on electrical cars. The hand movement required to operate this switch is extremely limited, so that in case of emergency the motor can be stopped and reversed in an exceedingly short space of time, reducing all possibility of collision with another car, or with any possible obstruction on the track, to a minimum. The new switch is entirely fire and moisture proof, is only about half the size of the present railway switch, and is arranged so that it can be carried between the wheels, underneath the flooring, where it is entirely out of the way, and where it occupies no valuable room on the platform. The control is by a vertical rod, passing up from the switchbox to the platform, and looking exactly like a brakero-d. A movement forward of this handle for the space of a quarter of a circle means ahead at full speed; a reverse movement of the same amount means backing at full speed, and there are all the combinations between, so that it is possible to regulate the speed of the car to any degree desired. This improved switch does away with all through wiring in the car, all possible sparking inside of the switch. In case of any obstruction upon the track, the advantages of the improved switch over old methods of controlling the motors is evident. The natural tendency, in case of an expected collision, is for the driver to jump back from his dashboard. By this movement he will carry his lever-handle with him, instantly reversing his machine without giving it a thought, and avoiding all trouble. This switch will be introduced upon all the Sprague electric railways which are now in course of construction.

Telephone at Coventry.—A telephone exchange of the National Telephone Company was publicly opened last Monday at Coventry with a preliminary list of 27 subscribers. Congratulatory messages were passed over the wires to the Mayor from the Mayors of Sheffield, Birmingham, Walsall, Bradford, and others. Mr. A. Coleman, of Birmingham, the company's general manager, said that it was a matter of some public importance that the city was now placed in communication with towns as far north as Bradford, Leeds, Huddersfield, and the intermediate places, while he hoped that in a few weeks Coventry would be connected with London itself. He said it might be thought that the company were a long time coming to a town like Coventry; they had had negotiations since February, 1886, but had received little support at the time. With regard to communications between centre and centre the company had, at the end of October, 1888, sent through their telephone exchanges 32,864,000 messages at a cost to their subscribers of 0.83 of a penny per message. After the opening the audience repaired, some to the Mayoress's parlour, some to two other rooms in the hall, in all of which instruments were placed. One set of wires communicated with Northampton, another set with Sheffield, Huddersfield, and Bradford, a third with Birmingham, and a fourth with Burton, Derby, and Nottingham. By the courtesy of the United and South of England Telephone Companies, communication was established for the evening with Northampton. In three or four of these places songs were sung and distinctly heard here, to the interest and amusement of the assembled companies. A pleasing half-hour was thus spent, and the obligations of the visitors to the National Telephone Company were increased by the hospitality offered.

Manchester.—The Corporation of Manchester, though owning the gas works, have announced themselves willing to introduce the electric light when it could be proved there was sufficient demand. The canvas recently undertaken by the Manchester Edison-Swan Company has shown that the support to be looked for in the centre of the city has been under estimated rather than over estimated. "Subject to a satisfactory arrangement as to the price," the people who were canvassed indicated their willingness to take 15,000 lights—50 per cent. more than the original estimate. This information has been submitted to the sub-committee of the Corporation. Since the Manchester Edison-Swan Company took the matter up the Anglo-American Brush Company have also made application for permission to establish a central station in Manchester. From unofficial statements, however, it is gathered that the sub-committee are not disposed to regard with favour any proposal to let either of the two companies secure Parliamentary powers of their own for the lighting of the centre of the city by electricity. It is thought that, as with gas and water, so with electricity, the supply should be to as great an extent as is wise and practicable in the hands of public bodies. With this object in view, the sub-committee will probably recommend the Council to apply for powers themselves, not with the intention of becoming producers and vendors of the electric light, but in order that they may licence a company or companies to supply the electric light in certain districts under certain conditions, probably to include a royalty to the Gas Committee to compensate for any diminution that may take place in the consumption of gas. The Corporation show a desire to introduce the electric light, with due caution, but yet not deterred from the fear that their gas undertaking may be jeopardised.

Dublin.—At the last meeting of the Dublin Town Council, the town clerk read a notice of the intention of the Irish House-to-House Electricity Company, Limited, 15, St. Helen's-place, London, to apply to the Board of Trade for a provisional order to authorise the supply of electricity for private and public purposes within the city of Dublin. The town clerk read a similar notice which was received from another company—Crompton and Co., Limited—who also propose to supply electricity for public and private purposes in Dublin. The town clerk said the Local Government Board had forwarded the report of Major Marindin in reference to the recent enquiry, at which the Dublin and Alliance Consumers' Gas Company sought powers to open the streets for the purpose of supplying the electric light to the Stephen's Green area. The report stated with regard to the capital that even if it were held that the refunded sums should be considered as old capital, which was somewhat doubtful, the amount actually available for electric lighting as estimated by Mr. Kean, the auditor of the Board of Trade, was only £10,000, and this sum was inadequate for an undertaking which was estimated to cost £15,882. The power to break up the streets would, if granted, place the gas company in a far better position than any other electric lighting company in the kingdom, and in a position which he did not think was contemplated by Parliament or the Board of Trade. In conclusion, the inspector said, "I have to report that, in my opinion, it is not expedient for the Board of Trade to accede to the request of the Dublin and Alliance Company, and to exercise their power under

the Act of 1883 by giving permission for the breaking up of the streets by the company for the purpose of electric lighting." The letters and the report were referred to the Electric Lighting Committee, who were empowered to take such steps as the circumstances of the case might require.

Accumulator Cars.—We alluded recently to the signs pointing to the increase of traction by storage cars in the United States, and the probable restriction of overhead lines. We see that the *Street Railway Gazette*, the most influential paper on the subject of suburban traffic in America, speaks in the same manner with reference to the development of electric railways, and, in an article on the storage battery, says: "We believe that it is pretty generally understood that the overhead system of electrical transmission will, sooner or later, be relegated to the past. For many reasons the system is not what is most wanted. The idea of each car carrying its own electricity, ready for immediate use, is certainly a fascinating one, and we do not hesitate to predict that as soon as the storage battery is brought down to a commercial basis it will be almost generally adopted. According to the best of our understanding almost all the advocates of overhead wire system have, way down deep in their hearts, a sneaking hankering for the storage battery. A very well-known gentleman, vastly interested in electrical transmission, recently made the following statement, 'What we are looking for is a good, sensible, commercially practicable storage battery. We have numerous storage batteries, some good, others indifferent, but all of great value in the laboratory. Now give us something cheap and practical. There is nothing the matter with the overhead and conduit systems, but what is wanted is a system by which we can transform our present cars into electric tramways, and go on running without all this fuss about overhead wires and underground cables, and one hundred confusing details.' The *Gazette*" (it adds) "has always been an earnest advocate of the storage battery, and looks forward to the time when street cars will be complete in themselves and carry their own power, motor, and equipment." There is no doubt that there is a good commercial and business spirit underlying such a statement, and this expression of opinion, coming as it does at the time of the mammoth amalgamation of storage battery and traction apparatus manufacturers in England, lends another confirmation to the ideas of the parties interested in this scheme of rapid extension in England.

The Telfer System for Brechin and Edzell.—

The village of Edzell, a summer resort near Brechin, in the North of Scotland, has been anxiously discussing the introduction of the telfer passenger system to connect it with the main lines of railway. The one drawback hitherto has been its distance from a railway station—that at Brechin, some six miles distant, being the nearest. From time to time proposals have been brought forward for establishing railway communication, and last year negotiations were made with the Caledonian Company, but nothing further has been done. The desirability of improved transit facilities has not, however, been lost sight of by the leading residents of the district, and a movement is now on foot to introduce the telfer system for passenger traffic. Mr. Philip, solicitor, of Brechin, when on business in Edinburgh, recently had his attention directed to the new system of transport, and on his suggestion Mr. A. R. Bennett, M.I.E.E., who some time ago brought the inven-

tion before the East of Scotland Engineering Association, came north and went over the route between Brechin and Edzell. Mr. Philip invited a number of gentlemen to meet Mr. Bennett on his return from his survey, when he expressed himself to the effect that the route was very suitable for a telfer line, especially from the fact that there was abundance of water power available to drive the dynamo. He estimated that the cost of a line for goods between Brechin and Edzell would be £8,000, and of a line for passengers £15,000, and that the actual cost to a company to carry goods would be about 8d. per ton. At that meeting a local committee was appointed to look into the matter, who decided to ask Mr. Bennett to send an engineer to make the necessary survey, and then they could suggest any alterations they deemed necessary. Mr. Manville, M.I.E.E., representative of the United Electrical Engineering Company, Limited, accordingly went down to Brechin and surveyed the route, accompanied by Mr. Bennett. On returning to Brechin those gentlemen met the local committee. Mr. Manville stated, assuming the maximum gradient to be 1 in 50, the telfer could carry along a net load of 10 tons at the rate of about six miles an hour. Mr. Bennett stated that the cost would be somewhat less than the above estimate if the power was got from the West Water near Dunlappie Bridge instead of from the Loups of the Burn. It was stated that the carriage of goods to Edzell at present cost from 4s. to 4s. 6d. per ton as compared with 8d. by telferage. A public meeting was thereafter held—Mr. Philip in the chair. The Chairman explained that Mr. Manville had just come from Wales where he had been surveying for a similar line, and he would be able shortly to give a definite estimate of the cost. His idea was that a sub-committee should be appointed to go over Mr. Manville's report, and after doing so report to the General Committee, after which the various proprietors could be approached with the view of ascertaining on what conditions they would grant way-leave; and, on learning those, another meeting would be held to consider the propriety of floating a company to carry out the undertaking. The sub-committee could be responsible for any preliminary expenses, which he estimated at about £60. He thought that such a step was at the outset necessary. The meeting generally acquiesced. The committee appointed were: Messrs. J. Shiell, factor on the Dalhousie estates, J. H. Lamb, manufacturer; Alexander Philip, Brechin; James Anderson, Westside; R. V. Cowan, Balbirnie Mill. Mr. Manville then explained the working and construction of the telfer railway. Small regard was had to any little inequalities in the route, or as to bridges, etc., which by the system were not required. The water power was a more serious consideration, but he thought that there was quite enough water in the source they had seen that day to propel one train at a time; and if they found that the water supply was at times inadequate, they could have recourse to a small steam-engine in an emergency. The speed would be about 12 miles an hour for a train of five carriages, each holding five persons. Trains could be despatched in quick succession, say, one every half hour, but it would not be at all necessary to confine the length of the train to that. They might have one, for instance, to carry 50 persons. He then explained the principle on which the speed of the trains could be worked, according as they were diminished or increased in size, and succession of despatch, and the advantages of such a system to the necessities of Edzell.

**"THE CAUSE THAT I DEFEND: 'TIS YOUR'S,
'TIS MINE."**

The same author whose line is placed at the head of this article says very pertinently, just previously, "You may spare your pains," but although this advice may be good, like much other good advice, it will not be followed.

The promoter is raging up and down the land preparing his schemes, and though some of these schemes are good, many may be bad or indifferent. Now, as ever, if the promoter succeeds, the public will have to pay the piper, and although told to spare our pains, we shall not hesitate to preach caution.

There has lately been a large registration of new companies. Our present purpose will be served if, for the moment, we give bare information without much comment. Among the companies registered are the following:

	Capital.	Shares.
Cambridge University and Town Electric Lighting Company	£50,000 in £5	
South-Western District and Thames Valley Electricity Supply Company	100,000	10
Croydon Electric Supply Company	5,000	5
Lancashire and Cheshire House-to-House Electricity Company	100,000	5
Liverpool House-to-House Electricity Company	100,000	5
Manchester House-to-House Electricity Company	100,000	5
Midland House-to-House Electricity Company	100,000	5
Northern House-to-House Electricity Company	100,000	5
Scottish House-to-House Electricity Company	100,000	5
South of England House-to-House Electricity Company	100,000	5
Western House-to-House Electricity Company	100,000	5
Yorkshire House-to-House Electricity Company	100,000	5
Irish House-to-House Electricity Company	100,000	5
Birmingham House-to-House Electricity Company	100,000	5
Devon and Cornwall House-to-House Electricity Company	100,000	5

A little more information about some of these companies may reveal the hands that turn the wheels and pull the ropes.

The Cambridge University and Town Company is registered by W. T. Bowman, 2, Earl-street, Cambridge, with the object to carry on at Cambridge the business of an electric light company. The first subscribers are:

F. C. Warr, 50, Datmen-street, Cambridge	1 share
A. Gildard, Brooklands-avenue, Cambridge	1 "
C. Armstrong, Newmarket-road, Cambridge	1 "
J. Pryor, Cambridge	1 "
E. Barnett, Cambridge	1 "
W. Fawcett, M.A., Cambridge	1 "
A. Barrett, Cambridge	1 "

There shall not be less than three nor more than seven directors, the first to be appointed by the subscribers to the memorandum of association. Qualification, £250 stock.

The South-Western District Company.—Registered by Trinders and Co., 47, Cornhill: to erect stations and works for supplying the electric light at Wandsworth, Putney, Barnes, Mortlake, Kew, Richmond, Petersham, Ham, Kingston, Surbiton, New Malden, Coombe and Wimbledon (editorial aside, all this with £100,000). The first subscribers are:

D. de Castro, 6, New-square, Lincoln's Inn	1 share
C. Hood, 53, Balcombe-street, Hackney	1 "
F. Williams, 4, Sherlock-road	1 "
G. Best, Ilford	1 "

L. Maskell, 38, Manor-street, Hackney	1 share
G. Leech, 16, Chetwood-road, Tooting	1 "
G. Duggan, Lynton House, Plumstead	1 "

There shall not be less than three nor more than 12 directors. The first to be appointed by the subscribers to the memorandum of association. Qualification and remuneration to be determined in general meeting.

The Croydon Electric Company is registered by Saxelby and Faulkner, 7 and 8, Ironmonger-lane: to construct within the borough of Croydon works for distributing the electric light. Registered without articles of association.

It will be noticed that the remaining companies in our list have the generic name "House-to-House," and it will be found that the whole of these have been registered by Slaughter and May, 18, Austinfriars, E.C., each with a similar amount of capital and with similar objects, and the same signatures to the articles of association, except in the case of Devon and Cornwall, where Mr. Hammond's name is accompanied by six new ones. Thus it will suffice to give two in detail.

Birmingham.—The objects are to form centres in Birmingham, or elsewhere in the United Kingdom, at which electric power may be generated or accumulated, and from which the same may be distributed by means of wires or other conductors of electricity for the purpose of lighting private houses, buildings, shops, factories, or works, or for the purpose of giving motive power for telephonic purposes, etc. The first subscribers are:

R. Hammond, 117, Bishopsgate-street, E.C.	1 share
C. Cornish, 132, Belvedere-road, S.E.	1 "
J. Whitehead, Crouch End, N.	1 "
T. E. Towerson, 1, Portland-road, Finsbury Park, N.	1 "
H. Bingham, 7, Bedford-place, W.C.	1 "
H. Mann, 2, Woburn-place, W.C.	1 "
H. Linklater, 117, Bishopsgate-street, E.C.	1 "

There shall not be less than three nor more than seven directors. Qualification, £250 stock. The first to be appointed by the subscribers to the memorandum of association. Remuneration, £500, and one-tenth of net profits after 7 per cent. dividend. [Our printer's d— (hush, the name must not be named to ears polite) would like to know how to work the oracle so that he can be qualified for a director. He says he thinks that he could manage to get on the right side of the editors if that is any recommendation.]

Devon and Cornwall Electricity Supply Company.—Registered by Slaughter and May, 18, Austinfriars, E.C., with a capital of £100,000 in £5 shares. Objects: to form centres in Devon and Cornwall at which electric power may be generated or accumulated for the purposes of street, house lighting, etc. The first subscribers are:

T. Graves, 15, Fore-street, Devonport	1 share
W. Sperman, 19, George-street, Plymouth	1 "
C. Mathews, Franklin-chambers, Plymouth	1 "
J. Walling, 32, Bedford-street, Plymouth	1 "
H. Matthews, 11 and 12, Bedford-street, Plymouth	1 "
C. Redford, 37, Bedford-street, Plymouth	1 "
C. Boulds, George-street, Plymouth	1 "
J. M. Gross, George-street, Plymouth	1 "
R. Hammond, 117, Bishopsgate-street, Plymouth	1 "

There shall not be less than three nor more than seven directors. Qualification, £250 stock. Remuneration, £500 per annum divisible, and one-tenth of net profits after 7 per cent. dividend.

Lastly, there is the Chili Telephone Company, with £250,000, also registered by Slaughter and May, but enough has been said to show the idea exists that "Electricity" is still a name to conjure with. Years ago, certain columns of the *Times* were dubbed the Hatched, Matched, and Dispatched Columns. Are not these terms somewhat appropriate to the consideration of the above and similar registered

companies? At any rate a good many are hatched, while no doubt a good percentage will duly be dispatched. Before condemning any of these schemes we must know more about them, and we urge the promoters, for their own sakes, not to be reticent in giving information. Liverpool and Birmingham have provisional orders. Are these new schemes in competition or in agreement with those previously known to us? Why is the capital in each case the same? Does that indicate that there really exists no engineering scheme, but only a promoter's selection of places where it is hoped a company can be floated?

LONDON CHAMBER OF COMMERCE.

REPORT ON THE FIRST SIX MONTHS' WORKING OF THE ELECTRIC AND ALLIED TRADES' SECTION.

(Revised and furnished to the Electrical and Engineering Press by order of the Section.)

This section was finally organised at a meeting of the trade held on the 22nd October, and a Working Committee was then elected. The committee was divided into the following sub-sections: Telegraph Companies, Telephone Companies, Electrical Manufacturers and Contractors, Electricity Supply Companies, Consulting Electrical Engineers, and General Engineers. The Electricity Supply sub-section was the first to get to work. On the 16th November, it met and considered the relations between the supply companies and the local authorities in regard to licenses and provisional orders. It recommended the Executive Committee to memorialise the Board of Trade that the unit should be increased from 1,000 to 10,000 watt-hours, also there should be united action on the part of undertakers in dealing with the question of paying the legal expenses of local authorities, as in some cases such payments had been demanded. It also asked the committee to urge all the electric supply companies to stand firm on the question of declining to sell undertakings at a shorter period than the 42 years' limit obtained under the recent Act; that supply companies should require two years as the minimum period in which compulsory work should be carried out; and that the model forms of accounts and general regulations for the electric supply companies proposed by the Board of Trade should not be issued until the supply companies had been at work for at least a couple of years, in order that these rules and forms of accounts might be issued after reasonable experience had been obtained to suggest the best form for them. These recommendations were confirmed by the committee at a subsequent meeting, and communicated to those interested in the trade.

Early in the year a sub-committee was appointed to consider the proposal of pushing the question of obtaining a Government laboratory for standardising electrical measuring instruments, and it was decided to take common action with the Institution of Electrical Engineers. Accordingly a joint committee was appointed, which met several times, and eventually, on June 19, an influential deputation, representing the Chamber of Commerce and the Institution of Electrical Engineers, attended at the Board of Trade, and laid before the President a scheme and estimate for such a laboratory. The deputation was favourably received, and there is every reason to believe that the matter will no longer be shelved.

The question of overhead wires was taken upon February 4 by a committee appointed to examine the matter. This committee held several meetings, and eventually has succeeded in obtaining a copy of the draft regulations intended to be issued by the Board of Trade for the regulation of overhead wires. The committee hope to be able to obtain some modification of some of the more stringent regulations proposed by the Board of Trade, and which appear to press hardly on the trade. At any rate, they have good reason to believe that their representations will secure the issue of the rules in a modified form for country installations.

A committee was appointed to see whether some modifi-

cation of the Chamber of Commerce rules respecting arbitrations could not be made, so as to invite members of the Electric Trade Section to avail themselves largely of such arbitrations as a convenient method of settling disputes in the trade, and eventually the permission of the General Council was asked to the following modification: That, as disputes on electrical matters at present were somewhat complicated, and involved much expert knowledge, that disputants should, if they so agreed, be permitted to avail themselves of the services of Counsel and expert witnesses in arbitrations otherwise under the Chamber's rules.

A committee was appointed to consider whether a standard form of specification could not be drawn up for the convenience of consulting electrical engineers on the lines of the specification very generally used by architects and builders. It was found, however, that for the present such a form of specification was not generally called for, and the idea was abandoned.

The question of the railway rates under the new Railway Act was considered as far as it referred to electric trades. A sub-committee prepared a report on this subject, which was presented to the General Committee on the 13th of May, and it was subsequently revised according to the form adopted by the Chamber of Commerce generally, and finally lodged by the Board of Trade and railway companies on June 3.

The Electrical Section enjoys great advantage in such cases in being able to avail themselves of the great experience and prestige of the Chamber of Commerce itself, on a matter which so greatly affects the future commercial interests of every member of the trade.

After the experience gained during the first three months the committee of the section decided that the amount of useful work done could be greatly increased if the section secured the services of a gentleman thoroughly acquainted with the trade to act as the section's correspondent, and after due permission had been obtained from the Council of the Chamber it was decided to ask Mr. Trotter to accept the post. Mr. Trotter kindly consented to this, and the result has been shown in the greatly increased volume of the useful work which has passed through the hands of the committee since the date of his appointment.

PROBLEMS IN ELECTRIC TRACTION.*

BY DR. LOUIS BELL, PURDUE UNIVERSITY.

The preliminary stage of electric tramways is to-day quite gone by. While three years ago such an application of electricity was regarded very dubiously, that doubt is now displaced by the certainty that the electric road is a success, and has come to stay.

The live question to-day does not involve the chances of the electric road, but the chances of its competitors. There are now something like 50 electric roads in regular daily operation in the United States, covering about 200 miles of track, employing all sorts of systems, working under all manner of adverse conditions, climbing grades of pitch equivalent to four and five hundred feet to the mile, taking curves of all possible radii, and there has been with all this no report of failure anywhere.

On very many of these roads electricity has replaced horses, and nearly every week brings reports of similar substitutions elsewhere.

No inroads have as yet been made on the cable systems, but it is an open question whether they can hold their own, even in the favourable localities where they are already established.

No one need ask, in face of these facts, whether electric traction is practicable or successful, but rather such questions as these: How efficient is it? What is its first cost, compared with horse or cable traction? How do its running expenses and repairs compare with these? What grades and curves can safely and economically be taken? What accidents is it liable to, and how can they be prevented? What are the conditions of efficient and economical running? It was for the purpose of attempting to answer some of these vital questions that the present investigation has been carried on.

* From the *Electrical World* (New York).

To obtain thoroughly practical results applicable to the everyday working of an electric tramway I have not concerned myself with theoretical motor tests and curves such as are detailed in Mr. Sprague's now famous paper on his Richmond road, but have confined myself quite closely to actual car tests of power and efficiency, and to the evidence of the ammeter and the indicator diagram at the power station. I do not at all underrate the value and importance of the above-mentioned theoretical curves, but that ground was so thoroughly covered in the paper in question that a repetition is needless. Furthermore, the man who contemplates putting his money into an electric road does not particularly care about the characteristic of the motor used, but he does want to know how much power must be developed on his cars, how much coal he must burn at the power station to obtain it, what efficiency he may expect from the system, what are its weak points, and how they may be strengthened.

Through the kindness of Mr. Hawter, superintendent of La Fayette (Ind.) Street Railway, every facility has been afforded me for making a thorough and detailed test of the road, and such of the results as may properly be published are recorded in this paper, only such details as directly concern the private business of the company being omitted.

Before taking up or discussing these experimental results, I purpose considering the general conditions under which electric roads must operate, the general difficulties to be met, and the relations of this method of rapid transit to those with which it has to compete. There are many requirements for street railway work which are not met with in any other kind of traction. For most of these the electric motor is admirably adapted, while for a few it is not. Consider, then, the conditions to be met in street railway work and the properties that a motor of any kind must have to be thoroughly suited to these conditions.

1. To meet public convenience, a tramway line must in nearly every case run through the most frequented business streets of a town, and outside the business portion must pass through, or very near to, the thickly-populated residence streets and on to the larger suburbs. It, therefore, is generally not at liberty to pick out a route of the easiest grades and curves, but must be able to surmount quite severe grades readily, and take without much danger of derailment any curves that the streets require, sometimes of radii barely above 20 feet.

2. It should be thoroughly reliable—i.e., track and motor system should be so constructed that the system will be of very little danger, first, of a complete breakdown, interrupting travel throughout the line, and, second, of local accidents sufficient to pile up cars at any particular point.

3. It should have a considerable flexibility in the matter of speed. In any line where the cars run on anything like a fixed schedule, as will always be the case in anything except the very largest lines, they must be able to make up lost time within reasonable limits in case of a trifling accident or unusually frequent stops. For this reason the maximum speed should be considerable.

4. It must be able to stop and start quickly and easily. Running through crowded streets and liable at any moment to find its tracks blocked, the only security against serious and frequent accident is in the ability to stop quickly, even when running at full speed. Easy and quick starting, too, is quite necessary, since so much of the running time is taken up in just this way.

5. Track and motor system should be of such a kind as will cause the minimum amount of obstruction to the streets and annoyance to the travelling public. For this reason the rails are very low and unobtrusive, consequently somewhat less secure. Since most of the traffic is, and will continue to be carried on by means of horses, any system that renders it difficult or dangerous to drive in the same street is open to objection.

6. The motor system should be tolerably silent, and of such a kind as not to prove a nuisance to the streets through which it passes. This condition, and the last practically, preclude the use of anything like the usual steam-motors, except in the rare cases where the line can be carried through unfrequented streets.

7. It must be so arranged as to meet readily the demands

of an unusual crowd at some one point. It frequently happens that most of the cars of a system must be started under nearly full load within a few minutes. This is specially true of lines connecting with suburbs, where the traffic is likely to be very uneven.

With all this, any tramway system must be tolerably economical in operation, and its first cost must not be prohibitive.

These conditions cover most of the points in street railway work, although in special cases they may be considerably modified. To meet these requirements all sorts of devices have been brought out. Of course, the use of horses is the principal method even now. Next in order come those motor systems which are modifications of the ordinary locomotive; then the cable traction systems, and finally the various electric systems. We have no concern here with the second class of motors above mentioned; they occasionally serve a useful purpose, but for everyday use in crowded streets they have been adjudged by common consent a nuisance.

Taking, then, the three systems in extensive use, let us see wherein they do or do not fulfil the above conditions, specially seeking out the weak points and difficulties of the electric systems.

So far as grades are concerned, the cable system easily takes first rank, for its power of hill-climbing is limited only by the power of the grip and the tensile strength of the cable. The grip is usually of the toggle joint form, and consequently, if necessary, a cable car can be made to take a grade practicable for nothing else except a cog-wheel road. Of course, such excessive grades are neither desirable nor economical, but now and then they are almost unavoidable. Sharp curves can, of course, be employed on a cable system, but with disastrous effect on the life of the cable and the efficiency of the system. The wear and tear on a cable with many curves is very severe.

With horses very steep grades are exceedingly objectionable, but by the aid of hill horses can be taken, except in slippery weather. At best, horses are far inferior to the cable system for grade work, though a horse car can safely take a curve that nothing else can, for the horses tend to guide and pull around the head of the car, while in any motor system there is a certain tendency to jump the track, even in spite of guard rails.

With electric roads the case is quite different. The motor cars depend on adhesion alone for hill-climbing, and beyond a certain point adhesion fails. In such a car, however, the whole weight of car and contents rests directly upon the driving-wheels in most cases, and consequently theoretically the possible grade per cent. should be numerically equal to the coefficient of adhesion. This can hardly be estimated exactly except by experiment in a given case, and street car tracks are generally not carefully enough laid to give good results. The data obtainable, however, would assign something like 20 per cent. as the maximum practicable grade, and the real limit probably lies below this. As to the evidence offered by actual experience under working conditions, it is certain that with proper care of the track grades as high as 400ft. per mile can be operated with entire success. This presupposes that the rails are kept in good order, and clear of sleet and snow. With extra vigilance in this respect, aided now and then by a little sand, I think it would be feasible to take grades of 500ft. per mile if necessary. Above a 10 per cent. grade the case is rather precarious when we consider the effect of rough weather. Occasional grades of greater pitch may be taken if they are not too long and conditions are favourable. As to curves, the electric roads are practically unlimited, but curves on grade are particularly undesirable, and in any case the speed should be reduced and the track well supplied with guard rails. Save on a steep grade there is no likelihood of trouble.

As regards reliability, one may divide the various systems into two general classes—those in which each car is an independent unit, and those where all the cars have a common source of power. The former class comprises horses and the electrical accumulator system; the latter, cables, and all other modifications of electric traction. All traction systems are liable to occasional local mishaps, but a general breakdown is very improbable in the first

class, while in the second it is likely now and then to occur. In the cable system this is most likely to be caused by breakage of the cable itself, either as a whole or in part—i.e., the snapping of one or more strands. In the former case the system is paralysed until the cable can be repaired, a period usually of several hours; while if the trouble comes from a broken strand or two, the loose wire can be cleared away in a few minutes and the cable run until stopped for the night, when a new strand can be inserted.

With the usual electrical systems a general stoppage, except in very rare cases, is due to a single cause, a serious short circuit at some point on the line. The wiring is usually arranged so that a broken wire, aside from the contact-wire, causes no serious trouble, and even if the contact-wire breaks, only a short section of track is thrown out of service. If a bad short circuit occurs, however, it may become necessary to shut down the entire line. But such an accident can be remedied almost as soon as the scene of it can be reached, and a broken wire is very easily mended. Electrical roads are, however, quite liable to minor accidents to single cars. Brushes will turn, trolleys will come off, gears will occasionally break, field-coils will now and then burn out and local short circuits occur. Most of these mishaps can be soon remedied, and not a few of them averted by a vigilant system of car and line inspection. In fact, I think it would be quite safe to say that three-fourths of these local accidents can and should be prevented.

Great power of varying speed is one of the characteristic advantages of the electrical systems. The speed may range from four or five, to fifteen miles per hour, at will, each car being separately driven and controlled. As the ordinary running speed is considerably below the maximum, trains can be made up quite readily, and the speed lowered very much in crowded streets without resorting to stops and starts. Horse cars possess something of the same flexibility, but their maximum speed is so low that with modern needs for rapid transit the horse car must eventually disappear. As is well known, cable roads work virtually at a fixed maximum speed and can only slow down by letting go the cable.

The same qualities that give an electric car a widely varying range of speed give it also the power of starting very smoothly and easily. In this respect it is decidedly superior to the cable cars, which, although they can be made to start with tolerable ease, usually do not. In addition, the electric car possesses an almost unique power of stopping suddenly in case of need. In a crowded street, it not infrequently happens that man or beast slips directly in front of a moving car. With horses or cable many accidents have resulted. With the electric car, however, the cases would be exceedingly rare in which a prompt reversal of the motors would not avert such a result, for if there is need, an electric car at full speed may be stopped within its length. I have seen a horse fall on the track within a few feet of a car at ordinary speed, and the car brought to a standstill without touching him. A man has been knocked down by the dashboard and the car stopped before the wheels reached him. Of course, such sudden stoppage is only attempted in case of dire necessity, but when that necessity comes it can be and is done.

So far as track is concerned, all tramway systems have about the same requirements. In the case of all motor cars of whatever kind there is more or less trouble from frightening horses, and, for a time at least, making the streets dangerous to drive upon. Every place in which a motor system has been started can show a record of a rather serious kind. It is certainly an important consideration. Horses, however, soon become used to motors and the main difficulty is only temporary. But all overhead electric systems, and all using the rail as a part of the circuit, are especially likely to scare horses on account of the frequent flashes from trolley or rails, or blazing at the brushes. I have known horses supposed to be thoroughly used to electric cars to become frightened at a brilliant flash and shy at the cars for some time afterwards, even dodging one drawn by a couple of innocent mules. With proper care of line and track, the flashing can be much diminished, however, and with

care the difficulty is not at all so serious as might at first appear.

As regards noise, electric and cable cars are at present not widely different. In the electric systems the incessant grinding of the cable all along the line is absent, but the noise of the gearing is often considerable, particularly after it becomes worn. At present, gearing seems the most feasible method of reducing the speed of the motors, but except when new, it is far from silent. The noise, however, of either cable or electric cars is not so great as to constitute a valid objection to their use.

With a proper plant, any of the electric systems can handle traffic massed at one point in a way that leaves little to be desired.

(To be continued.)

REPRESENTATIVES AT PARIS.

The following is a list of Englishmen and Americans representing electrical exhibits at the Paris Exhibition. We shall be pleased to add others not here included if they will forward their names and addresses by writing the particulars of the exhibits they represent or are employed upon:

ENGLISH.

R. E. Crompton and Co., Limited.	J. A. Berly (representative), 40, Avenue de Suffren, Paris.
	X. Gosselin, in charge of stand, British Section, ditto.
Ferranti and Co.	E. Bloxham, in charge of Ferranti exhibit, Pont D'Jena, Exposition, or 9, Rue du Pont du Jour, Auteuil, near Paris.
Illius A. Timmis	F. W. Ketley, 13, Boulevard Saint Germain.
Eastern Telegraph Company	H. Thomas, Hotel Burgundy, 8, Rue Duphot.
Paterson & Cooper	R. Aylmer, British Section, Palais des Machines.
Mayfield and Co.	ditto ditto
Elliott Bros.	ditto ditto
Globe Electrical Engineering Company	ditto ditto
Davis & Timmins, Limited	ditto ditto

AMERICAN.

T. A. Edison, New Jersey, U.S.	General manager, W. J. Hammer, Edison Exhibit, American Section, Palais des Machines. Draughtsman and assistant, R. F. Outcault, ditto.
Thomson - Houston Co., Boston, Mass. U.S.	General Agent for Europe, J. F. Meech, American Section, Palais des Machines; and Hamburg. General business agent at the Exhibition, E. Thurnauer. Electrician in charge, F. J. Parsons. Welding Department, A. S. Garfield, 12, Avenue D'Antin. Representative for France, Victor Popp, Compagnie Parisienne de l'Air Comprimé, 6, Rue Franche-Comté. In charge of boulevard lighting in Paris; G. J. Melms, 103, Boulevard Margenta.
Heisler Electric Light Co., St. Louis, Mo., U.S.	A. Graner, secretary to the company and agent for Europe, American Section; or 1, Avenue Montaigne.
Elmer A. Sperry, Chicago, U.S.	Representative, John F. Kingswill, Box 100, American Section; or 7, Passage Bosquet.

SWISS

Oerlikon Works.	E. P. Jackson, Emplacement d'Oerlikon, Section Suisse.
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MESSRS. B. VERITY AND SONS' ELECTRIC LIGHT FITTINGS.



Silver and Brass Bracket.



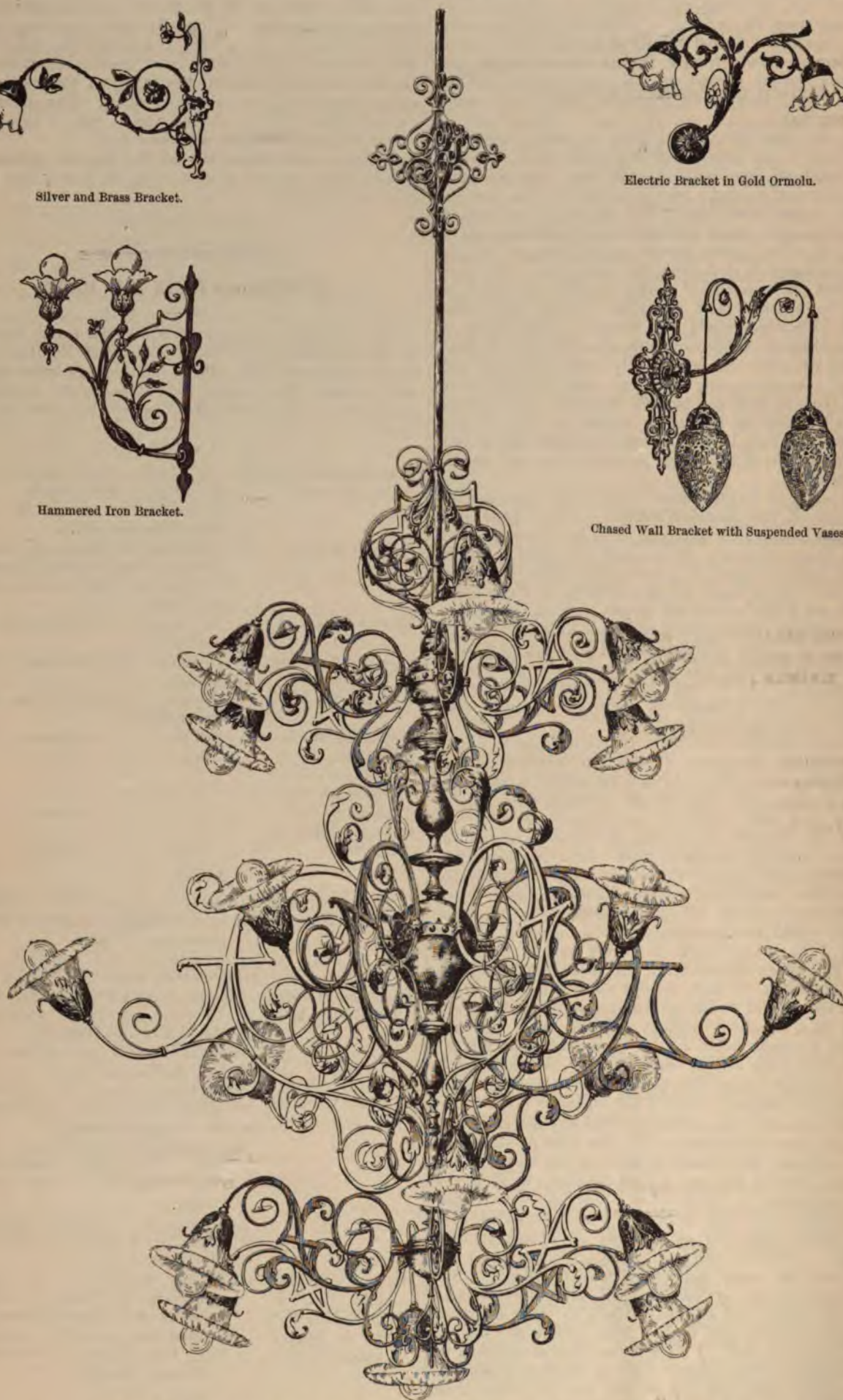
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Hammered Iron Bracket.



Chased Wall Bracket with Suspended Vases



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THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence ; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices :

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, 139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.

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IMPORTANT NOTICE.

The index of last volume was given with our last week's issue, and every purchaser should have received it free of cost. The present issue commences a new volume, and the present will be found a suitable time to commence subscriptions. In the forthcoming half-year will appear the descriptive matter relating to the Paris Exhibition, also during this part of the year the British Association will be held and the Birmingham Exhibition open.

Specimen copies of the paper will be sent on request.

CONCERNING PATENTS.

One of the most difficult things for business humanity is to be perfectly just when the question under consideration is connected with patents. There are so many phases to this patent question, and they are so interdependent, that it is almost impossible to consider singly any one of them. A careful investigation of patents, and especially of patent cases, will show that in almost every case the germ of the commercially worked patent can be found in papers or previous but unworked patents. Frequently a patenting expert patents what is to him merely an expression destitute of tangible reality—that is, the patentee has no real grasp of the ground covered by the verbal expression in his specification, nor has the idea expressed been tested by means of a model for its utility, nor is there any intention of so testing it. Years pass by, other inventors arise, new developments are studied, knowledge progresses, and machines are made which depend in some way or other upon the principle embodied more or less ignorantly in the verbiage of the older patentee.

One of the first results of the successful introduction of a new piece of apparatus, and especially if it be patented, is the stirring up of the envy and hatred, not of every other member engaged in the industry, but of every man who, because of the prominence given to the particular industry by the new departure, wishes to enter the industry and to manufacture, use, and sell the apparatus which has led to the increased activity. These new men entering the industry, knowing little of its technicalities, are aggrieved because their crude efforts lead to the design of something which they are prevented from selling, being infringements of some prior patent. These are the men who, in the electrical industry, have given no proof of initiatory powers, but are quite capable of taking somebody else's machine, modifying it slightly, and calling the modification a new invention. The whole system of patent laws seems to be desperately weak, and civilised society a funny concern, when in many instances those who have least claim to originality are just those who make the most profit out of a new introduction. To illustrate what we have to say by means of concrete examples would probably land us with a dozen libel suits, but it is easy for the reader to supply his own examples. It will please him and hurt nobody. There are two classes of men connected with patents whose work is of world-wide benefit—we refer to original inventors, and to business men who make the inventions practical. The original inventor seldom produces an apparatus that is at once of commercial value. The germ is there, but it must be placed in other hands to develop. Which of these two classes is the greater benefactor to the human race it is difficult to say: both are required, both should be considered. It is,

perhaps, quite as hard to convince the world that it wants something, as it is to invent something, that the world may, when properly educated, find absolutely necessary.

There seems to be a weak point in all patent laws which admits of an improver reaping as great or greater rewards than the original inventor. In fact, as we have previously suggested, the real inventor has more frequently than not to be satisfied with seeing improvers get the money which he, in justice, ought to receive. Almost every man is of the same mind as Cawthorn, who

had once a mind to fix
His carcase in a coach and six,
And live if his estate would bear it
On turtle, ortolans, and claret.

Hence the improver is always studying what new thing he can take up, change the size of a screw or the shape of a nut, obtain a patent as if his work was original, sell to the public, and live happy ever after. Four classes connected with patents have now been referred to: (1) The real patentee or original inventor, (2) the business man who deals commercially with the things patented, (3) the professional patentee or producer of fishing specifications, whose ideas are crude and unproductive, but sometimes sufficiently comprehensive to obtain a royalty from a practical inventor quite innocent of plagiarism, and (4) the improver, who never really invents but only improves. Putting aside the commercial man, the others are treated alike by the present system, and yet it can hardly be contended that the work of each possesses similar value. It may be impossible to legally make a distinction. Yet surely the inventors who really open up a new industrial branch of manufacture should take a different position, as patentees, to the thousand and one improvers who have followed with specifications. We do not for a moment deny the value of the improver—the only class mentioned with which we have little sympathy is that of the fishing patentee whose patents are never worked, and only stand as stumbling-blocks to workers. Without the improver many an invention would remain almost valueless, and the only difficulty in apportioning his position, results from being unable to determine what improvements the real inventor would naturally make when his designs were manufactured and used. Perhaps our meaning is not quite clear. Assume an invention patented and the specification published. A hundred minds are turned to the study of the apparatus, and it is strange if some of these do not see the way to some modifications which will improve the apparatus. Given the invention, many who could not have invented can improve. Patenting the improvement often cuts out the original inventor, and leads to litigation. In the electrical world the lawyers have probably made, next to company promoters, the greatest sums out

of patents during the last ten years, and we fancy most of the litigation has been between inventors and improvers. We refrain from attempting a moral, and are content with pointing to the situation, which, to say the least, is eminently unsatisfactory.

ELECTROLYSIS OF BISMUTH SALTS.

BY ALEXANDER WATT.

In selecting bismuth as a subject for electrolytic investigation I was desirous, while determining the behaviour of its salts under the influence of the current, to ascertain which of the salts of bismuth, alone, or in combination with other substances, would be most suitable for preparing depositing solutions for coating metals with bismuth for useful purposes in the arts. It has been my endeavour, as expressed in former papers, to point out to electro-platers that many pleasing effects may be produced in art-metal work by coating various parts of an object with metals of different shades of colour, and amongst these bismuth should certainly hold a place; the agreeable pink tint of the metal would, I think, render it a pleasing contrast to other surfaces in pieces of ornamental brasswork, such as gaseliers and electroliers, for example. Although bismuth is a dearer metal than either nickel or cobalt, it must not be forgotten that only a very small quantity of the metal would be required to be deposited, since its utility would depend chiefly upon its colour, and as the bismuth-plated surfaces could readily be protected by a thin coating of colourless lacquer, there would be no necessity for the deposit to be stouter than a fairly good film. To deposit bismuth from the solutions which are most suitable for practical application, and to which attention will be drawn, a weak current only is required, and the deposited metal may be rendered sufficiently bright by means of light scratch-brushing, with brushes of very fine wire, moistened by a continuous flow of beer-and-water—about equal parts of each.

1. *Acid Sulphate of Bismuth (Supersulphate).*—A solution was formed by heating powdered bismuth in strong sulphuric acid. The solution thus obtained was poured into water, and after allowing the white subsulphate formed to deposit, the clear liquor, consisting of supersulphate of bismuth in water, was electrolysed with the current from a single small Daniell battery, a plate of bismuth being used for the positive electrode, and a clean strip of brass 3in. by 1in. for the cathode. Soon after the latter plate was immersed in the bath it received a coating of bismuth of the characteristic pinkish colour, but the deposit turned a dull black colour after about one minute's immersion. The plate was then cleaned, and a smaller anode surface exposed, when on reimmersing the plate it received a further deposit of metal more gradually, and the blackening of the plate did not occur so quickly as before. It was now deemed advisable to further dilute the solution with water, when the films subsequently obtained somewhat improved; but since the plate last introduced still turned black at the edges, it was resolved, with a view to secure a reguline deposit, to gradually add a solution of sulphate of potassa.

2. *Sulphates of Bismuth and Potassa.*—To the above solution was added, a little at a time, a strong solution of sulphate of potash, and it was noticed that even when only a small quantity of this salt had been introduced the metal deposited in a better form, and not quite so quickly as in the former case. After ten minutes or so, however, a dark non-reguline layer formed on the surface of the film first deposited, which was readily rubbed off with the finger. A further addition of water was next given, and a fresh plate immersed, which soon became coated with reguline metal, and retained this character for a much longer period than before. On examining the anode, it was found to be coated with an opaque white layer—probably a subsulphate.

3. *Sulphates of Bismuth and Ammonia.*—Being desirous of obtaining a solution of the sulphate of bismuth more readily than by heating the metal in sulphuric acid, I adopted the following method: A dilute solution of sul-

phuric acid was first made (about one part acid to three parts water), to which was gradually added recently precipitated and well-washed carbonate of bismuth, which dissolved very freely in the acid liquor. A slight excess of the carbonate was given, and the solution then filtered for use. A moderately strong solution of sulphate of ammonia was next prepared, to which was added a portion of the bismuth sulphate solution, and the bath thus formed was electrolysed with the current from two cells, when a deposit of bismuth was soon obtained upon a freshly-prepared brass plate. There was no disposition for the metal to deposit in the black non-reguline, or spongy state, but it was found advisable to moderately dilute the liquid as the metal assumed a somewhat dark colour after a few minutes' immersion of the cathode. The weakening of the solution, however, had the desired effect, and the films afterwards obtained were greatly improved in appearance. It is probable that a bath of this nature, if carefully prepared, would form a useful solution for the deposition of this metal. It should be stated, however, that after a time a white insoluble subsalt forms on the surface of the anode, which would necessitate scouring the plate from time to time. During the trials of this solution (which was in an acid condition), it was at one time nearly neutralised by the addition of a few drops of liquid ammonia, but the effect not being favourable, it was again rendered slightly acid by the addition of a few drops of dilute sulphuric acid, when the bath at once improved and the deposits afterwards obtained were more satisfactory. It was noticed that the metal deposited from this solution was whiter than is usually the case with deposits of this metal.

(To be continued.)

ARTISTIC FITTINGS.

V.—MESSRS. B. VERITY AND SONS, COVENT GARDEN.

Amongst the producers of electric light fittings in England, there is one firm who have achieved, it may be said, pre-eminence in the beauty and variety and multitude of their designs for artistic fittings. It will be readily understood that we refer to Messrs. B. Verity and Sons, of King-street, Covent Garden. We have had some trouble to do justice to the beauty and elegance of their designs in our illustrations, the preparation of which has taken some considerable time, but we trust the result will be to give to our readers and to the world in general interested in electrical engineering some specimens of the taste and variety of Messrs. Verity's designs. Some of these are reproduced from the very beautiful catalogue recently issued by this firm, but many are prepared from drawings selected as typical examples of their fittings from the large numbers specially prepared for important customers, or for large private installations. They represent that type of decorative fitting now becoming general, in which the artistic appearance of the incandescent lamp is utilised to the utmost by the free use of floral and scroll metal work of light and fanciful pattern—in wrought brass, in copper, in iron, or bronze—produced in shapes and colours which blend harmoniously with the æsthetic "arrangements" or the oriental splendour of most of the better class habitations of modern life.

In these fittings artistic excellence has been sought to be combined with realistic or naturalistic floral patterns. Messrs. Verity have, to their great success in this field, secured the services of a designer of almost unlimited resources and real artistic feeling, Mr. S. Crichton Hannah, who has shone in other and more "legitimate" fields, for we believe paintings by him are not unknown at the Royal Academy. Our readers will be able to judge for themselves of the elegance and appropriateness of the fittings to the purposes for which they were intended. It may be interesting to add that at one time, when patterns for the floral hammered work were required, considerable sums of money were constantly expended in the adjacent markets of Covent Garden for freshly-cut flowers of special or varied beauty, from which the modellers copied—in wax—the leaves, petals, and tendrils, for exact reproduction after-

wards in cast brass or in hammered metals. A large stock of beautiful floral forms have been thus acquired, which have now passed into the region of conventional art, and are familiar to all admirers of decorative fittings.

DESIGN AND MANUFACTURE.

Before describing more particularly the specimens we have chosen to illustrate the various types supplied, it will be interesting to glance at the process of manufacture through which artistic fittings have to progress, with also some account of Messrs. B. Verity and Sons' workshops.

Electric light fittings, irrespective of their artistic merits, fall naturally under two heads—Cast work and Hammered work—from the process of manufacture followed in each case. In the latter category, again, there are important distinctions:

- (a) Repoussé work, hammered or punched from the back in the sheet metal.
- (b) Chased work, done with a chasing tool on either cast or hammered work.
- (c) Hammered or wrought work, in either brass, copper, bronze, or silver sheet metal, hammered cold.
- (d) Hammered or wrought iron, hammered hot.

The first category—cast metal work—comprises the usual run of electric fittings. These are cast from metal patterns, obtained, in the first place, from wood, or more often from wax models. The castings are filed up, and "scratch-brushed," burnished, and lacquered; or simply bronzed or lacquered according to taste.

In Messrs. Verity's works the designs emanate mostly from Mr. Hannah, who, after ascertaining the views of the person requiring the fittings, makes sketches, submits them, and, after approval, finishes the details of the design and superintends the working drawings. When the drawings are ready the orders are passed into the factory; here the patterns are made or castings from stock are given out, and taken to the workmen in the different departments for finishing and making-up. It must be stated that a large proportion of Messrs. Verity's workmen—hammerers, chasers, and smiths—are really artists in their own materials, giving, to a large extent, expression to their tastes of skill, and taking great interest in the varied work before them. It is easy to see on visiting these interesting works that the class of men here employed are very superior in appearance, intelligence, and appreciation of idealism to the ordinary workers in metal: many of them have been trained from their youth in these shops, and all take great pride and pleasure in their work.

In cases where special patterns are required models are first made by expert modellers in wax. These are afterwards cast in brass, finished by the chaser, and kept as permanent patterns from which to obtain moulds for present requirements and for future repetitions of the orders. The next process is the casting in brass, many men being constantly employed as brassfounders, not only for the artistic fittings, but also for parts of switches and other apparatus. After this comes the making up or putting together of the whole pendant or electrolier. For plain brasswork this finishes the working of the metal; the fittings are then either polished or burnished, and lacquered in colours according to taste—natural brass, bronze, gold bronze, steel bronze, or black bronze. The lacquering is a process requiring some skill and chemical knowledge, and Messrs. Verity have a special lacquer in gold ormolu to almost exactly imitate electro-gilding, for which the firm are famous.

In the better class work the finishing process is often water gilding with gold, or gold or silver electro-plating, or plating with oxydised silver, all of which give a rich and luxurious appearance to the fittings.

THE SHOWROOM AND WORKS.

The works of Messrs. B. Verity and Sons are well known to most of our readers: the large and handsome showroom situated just at the back of Covent Garden Market with its display of luxurious and handsome fittings in all the beauties of gold and bronze, lace, mirrors, and coloured glass—the decorative part of electric lighting; and in another window a typical small steam-engine and Edison dynamo furnished with cut-outs and switches—the generating part, for Messrs.

Verity do not by any means confine themselves to the manufacture of fittings, but are always busy carrying out installations in all parts of the country, for country houses, or for public institutions. One of the latest of their private installations is that for Lord Rosebery's house at Mentmore, near Leighton Buzzard, where there are some 700 or 800 lights, with engines, dynamos, and accumulators. Messrs. Verity have also recently fitted the magnificent house of Lord Fife in Cavendish-square, adapting the old girandoles, and also making special arrangements for the pictures, perhaps the finest private collection in London ;

beyond that of England in the number and extent of their central stations and the application of electricity in practice, yet in the question of artistic development and the adaptation of beautiful fittings for home use the Americans are always far behind the best English practice, and are usually glad enough to learn from and purchase their art from European sources.

The firm is quite an old one and has carried on the business at these premises for two generations, originally principally in the same class of gasfittings, but for the last year or two the trade in gasfittings has dwindled



Pendant Light with
Iced Bowl.



Large Electrolier in Chased Brass—Iced Glass with Coloured Jewels.



Gas and Electric Combina-
tion Pendant.
Silver and Brass Leafwork.



Floral Bracket in Hammered Brass.



Repousse Panel with Floral
Bracket.

and among public institutions, one recently supplied with fittings is the Glasgow Municipal Buildings, for which this firm made the greater part of the elaborate electroliers ; and another the new Savoy Mansion on the Thames Embankment, for which they have fitted some 3,500 or 4,000 lights. The showroom of electric fittings is certainly one of the sights of London for electrical engineers, containing as it does, perhaps, the largest and most varied of artistic electric light fittings in England, and American electrical visitors might certainly do worse than make it a point of pilgrimage, for however the American practice may be

away, owing to the introduction of electric light, until at present they hardly do £200 worth of work in the six months. At the same time the business in electric light fittings has grown to such an extent that they have twice found it necessary to extend their works, and have taken large additional premises adjoining or at the back of their original works, which have been fitted up throughout with modern machinery and lathes for the extended production both of the artistic pendants and brackets and for switch cut-outs and sundry small apparatus for electric light installations.

The firm employ at times some 350 men, engaged on the works and in the outside departments, though this varies, of course, with the state of business. As a rule, there are over 200 men permanently employed in the works. The staff consists of the chief engineer, the sub-engineer, two chief electricians, four electrical inspectors, 12 or 14 foremen of the different departments, one head designer, and two draughtsmen, besides office staff. There are usually some 20 to 25 chasers, and 12 or 15 artistic ham-

death, and, for sociality and athletics, a football club and a cricket club, holding, also, musical evenings amongst themselves in the winter—one of these *réunions* we attended with great pleasure last winter, and were delighted at the culture and good fellowship of the members.

The original showroom and workshop in King-street, Covent Garden, was considerably added to some five years ago, and another large new factory has been added during the last few months for the better organising of their usual



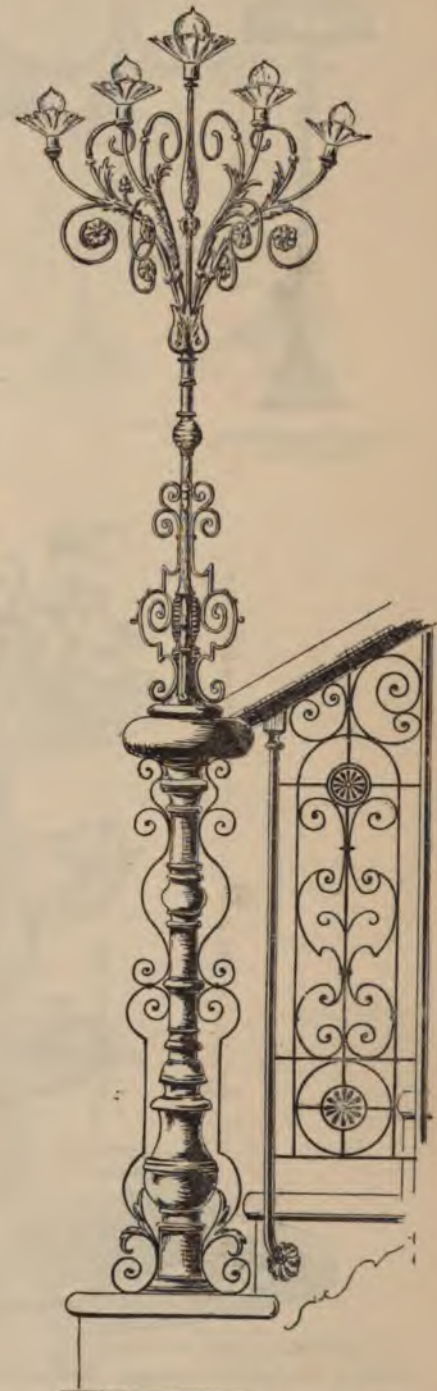
Combination Electroluer for Gas and Electric Light



Pendant Light with
ced Shade.



Mirror Bracket—Repousse Copper
mounted on Plush.



Wrought Brass Newel Standard
for Hall.

merers, and 8 wax-moulders and pattern makers; the remainder are skilled and unskilled mechanics and fitters, etc., at the workshops, and electrical wiremen employed on installation work. It can easily be seen that this staff means a very large amount of electric lighting work now annually carried out, and serves to give some idea of the extent to which this new department of electric fitting has grown to in modern life.

In connection with the employes of the firm there is a sick club for the benefit of the members out of health or at

work, and for the manufacture of all kinds of electrical apparatus. The entire works is conveniently divided into five departments: (1) Offices and showrooms; (2) manufacturing, turning, polishing, carpenters and joiners; (3) piece workshop; (4) stores; and (5) packing-rooms, adjacent. The works are supplied by a 40 h.p. Marshall boiler and a Robey engine, the boiler also supplying steam for boiling throughout the works, heating the sawdust pans, drying the lacquer, warming the offices and showroom, and for heating purposes throughout the factory. A Schiele blower

supplies the workshops with air blast for the smith's forges, and for the gas blowpipes. The showroom, as has been mentioned, fronts on King-street, on the ground-floor, with the offices alongside; upstairs are the drawing offices, and at the back the workshops extend in both directions. The stores run the length of the building on the basement, and here we see the greatest neatness and order, divided into their respective departments, with all facilities for immediate production of goods in stock—casing stacked in long frames, miles of insulated wire and cable, small electric fittings, sockets, cut-outs, switches, etc; electroliers, brackets,

curls in imitation of foliage for the production of the pendants and brackets, some of which we see finished and hanging up on the walls. In another room we see the burnishing in progress: steel burnishers deftly wielded, large and small, to suit the parts of the fittings, and the surface of the brasswork gradually assuming a brilliant polish under the workman's manipulation. Further along the scratch-brushing and polishing—the revolving wire brushes rapidly producing a surface like dead gold, and the polishing by means of sand and lime putting a last touch before lacquering. Then the lacquer-rooms, the fittings



Simple Standard with Paper Shade.



"Griffin" Portable Standard.



Cut Glass Epergne, for Fish, Fruit, Light, and Flowers.



Large Bell Shade Pendant in Ice Glass for Two Lights.



Portable Standard—Chased Brass, Silk and Lace Shade.

and all varieties of fancy fittings; glass shades and globes; and lastly, incandescent lamps in thousands, sorted according to description and voltage, safely packed for distribution or counting.

The pattern department comes next, with its complement of workers in wood and wax; and the casting department, with its moulding shop and brass foundry. On other floors we see the brass finishers and fitters, hammerers at work on beaten leaves in copper or brass; in another room a row of smiths at work at wrought-iron work with their little forges, their anvils, and the working drawings in front of them, and the thin black ironwork in twists and

and parts laid out on steam-heated tables and quickly touched all over with the lacquer brush. This is a girl's or woman's work, and considerable numbers are employed, many of them of great skill and facility in this occupation, and earning good money, for quickness, skill and judgment are required. A good lacquer is most important in polished metal work, and Messrs. Verity say that their lacquer will, if wiped occasionally, keep colour and brilliancy for 15 years.

In another department we see the chased and *repoussé* work in progress: hammered brass for backs of sconces or mirrors, globes of pendants, or feet of standards, in patterns

of low relief, fruit, flowers, birds, or animals: and the heavy antique chased work, twisted and cut, with varied pattern, in the style of Louis Seize, gilt and burnished, with edges in gold cord, or in all the varieties of patterns from the chaser's tool. A further room is occupied in fitting the various parts of electroliers, pendants, and brackets together, and giving the finishing touches, before they are sent aloft for papering up, before dispatch to customers, or putting by for stock. The stock of the fittings in general request is very large; every article shown or described in their illustrated catalogue is kept for instant delivery, and can be taken out or made-up almost at a few minutes' notice ready for delivery—not singly only, but in quantity. The

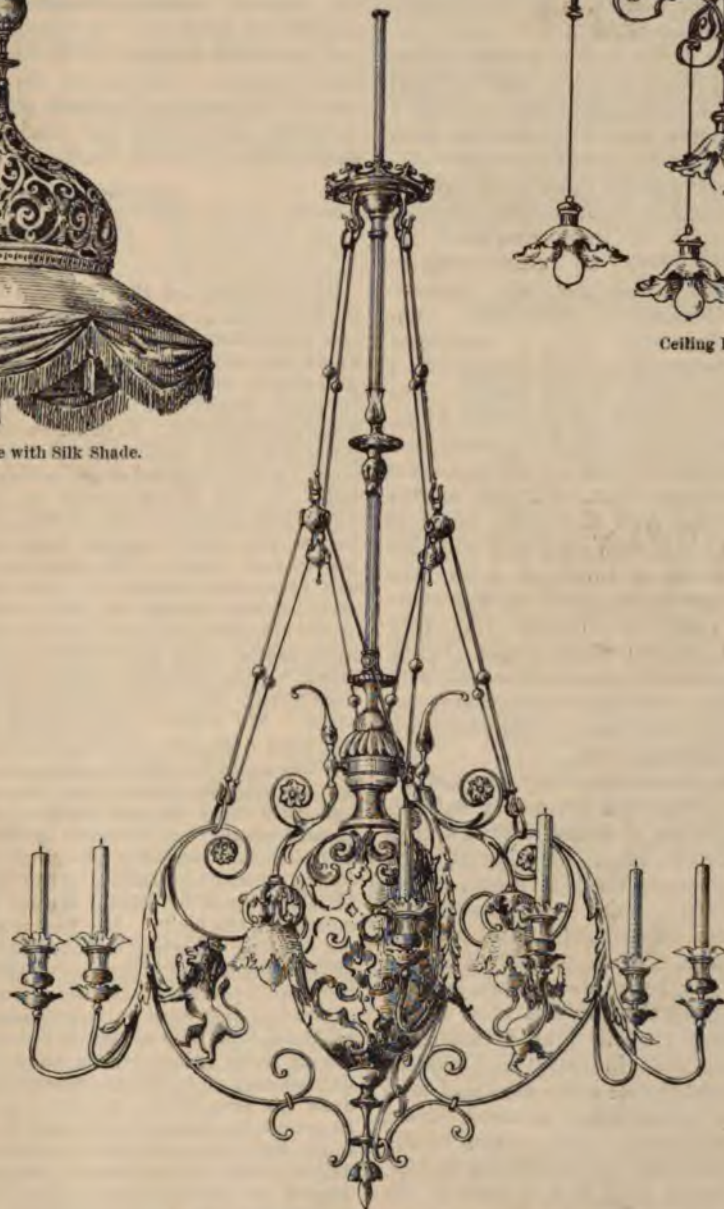
spoken of in electric light installations. Roses for ceilings, clips for adapting to gasfittings, are part of the manufacture, while large switchboards, fitted with sets of switches and contact pieces, and rows of fuses, for theatres and large institutions, are always on hand. Apparatus in quantity of this kind is mostly done by piece-work, each man or boy working at his own bench or lathe with his heap of slate, metal, or wood pieces—forming part of the switch, fuse, or other article—growing in bulk beside him. It is interesting to mention that except insulated wire and glass, the requirements for electric light fittings are largely manufactured and completed direct out of raw material at these works; the brass is



Pierced Brass Dome with Silk Shade.



Ceiling Fitting



Electric Chandelier—Copper Ball, with Pierced Brass.

capacity of the works in manufacture can be judged from the fact that the whole of the fittings for the Hôtel Métropole were manufactured—most of them of special designs—and delivered within five weeks.

The electrical apparatus department takes up a large space, mostly in the new factory. Parts of fittings, mechanical movements, screws, switches, cut-outs, sockets—all the thousand and one little mechanical details of electrical engineering, are turned out by the gross or the thousand. These are not made only for their own use, but for the trade in general, and special machines, and lathes, or turning tools, are adopted for saving time and labour. The little drop-handle switch, which is shown in our illustration, is made by many thousands at a time, and is very well

bought in ingots and melted down for all the castings; or for the parts of hammered or worked fittings, is worked from sheet, tube, or rod metal; while carpenters and joiners do all their own woodwork, so that the second profit on working is saved.

The packing is conducted in a department to itself, and the greatest care is evidently taken to secure safety, and cleanliness in packing and delivery as well as quickness in making up and send off the fittings ordered.

THE FITTINGS.

Our illustrations show a number of Messrs. Verity's fittings, typical of the various designs and processes we have mentioned. The large 18-light electrolier is now to be seen in the Venetian hall of the Holborn Restaurant, its

graceful wrought spirals of brass intermixed with floral coloured glass shades making a handsome and imposing centre fitting for a large hall. It is a good example of what has been said with reference to the lasting qualities of the lacquer, that at this restaurant, amongst constant use and heat of the rooms and in spite of dust, dirt, or flies, the colour of these fittings, after six years, are now as good as new.

Of a different style of fitting are the numerous little pendants and brackets with light hammered leaves, to the tendrils of which hang the incandescent electric globes as fruit or flower to a plant. Some of these are shown in delicate brackets of wrought silver and brass mixed; others in gold ormolu lacquered. A combination single-light pendant, for gas and electric light, with silver and brass leafwork, is in the same style. A cut-glass épergne, mounted with incandescent lamps, with a bowl for gold-fish, and spaces for fruit and for flowers, is a most lovely combination for the artistic dinner-table.

A pretty adaptation for the wall is that of a panel representing fruit in pierced and *repoussé* work, with a floral bracket, while for the top of a library bookcase or a lady's wardrobe is a light and simple three-light bracket, with leafwork and flowers, making a very graceful fitting.

The combined use of gas and electric light, or, where gas is not used, of candles and electric light, is often adopted in houses, and two examples of these combined fittings are shown, the one with an electro-gaselier for five lights, with chased ornaments and *repoussé* ball, and the other a Renaissance chandelier combined with electric light, the latter with a burnished copper ball or centre covered with pierced brasswork, a method which gives a very rich effect to the fitting. The large electrolier for a drawing-room or large public room, with seven lights, is in chased brasswork, hung with iced glass vases, which are manufactured with ruby bosses cast therein to give a varied coloured effect. Fittings of this kind are extensively used in the West End clubs, many of which have been fitted up by Messrs. Verity and Sons for electric light, the current being obtained from the Grosvenor circuit. Single pendants, fitted with similar iced or frosted glass vases or bowls, are very largely used in private houses for single lights, and present a pretty appearance in conjunction with artistic or oriental hangings. A simple form pendant for several lamps, with cords dependent from curved brasswork close to the ceiling, is very light and neat.

Wrought ironwork is also now extensively adopted, its sombre colour being atoned for in the grace and naturalness of its form. An example out of many is shown in a stiff wall-bracket. The pierced brass dome, with silk hangings, illustrates a fitting largely used in dining-rooms or boudoirs for reading, where a quiet and concentrated light is required. These are often made with counterweights to pull up and down. The combination of the electric globe with the ordinary house decorations is often attempted, one of the most usual being that of a mirror mounted on plush, to which electric light is attached. Portable standard lamps are used in many and various forms, from the most plain and simple little standard with a paper shade, to delicately chased brass or silver work, with crimson shades and lace fringes. Fancy forms of the portable standard are often made, and one interesting design, the "Griffin" standard, gives a good idea of some of the varieties in which these little lamps are made. The standards are all made portable, with a long flexible cord, furnished usually with a socket, which can be slipped into a corresponding wall socket in various parts of the room.



New Cut-Out.



Lever Switch.

The form of lever-switch largely introduced into private-house lighting by Messrs. Verity is worthy of notice, and is shown in a small cut. The action is distinct from that of the turning of a tap, and is often preferred; it is effected by the tipping up or down of a small lever handle, which releases

a spring. The new form of cut-out is also shown; in this the fuse is mounted on a removable plug, which can be taken out to adjust the fuse—a great convenience in fitting. Moreover, the fuses for various numbers of lamps are not the same in size, and a plug of larger capacity than that for which the cut-out is suited, will not fit the socket, and the circuit is thus kept from being overrun.

A form of electric standard for the newel post of a staircase is shown, to illustrate the manner in which fittings are often designed to correspond with their surroundings; it makes a fine addition to the appearance of the hall in which it stands, and at night furnishes a splendid light for visitors descending from their carriages, or bidding farewell to their hosts.

It is hardly necessary to point out that a firm so prolific in the beauty and variety of their designs is not likely to stand still in the production of fresh types, and even at the present moment Messrs. Verity have produced a number of fresh and very beautiful designs in hammered and burnished copper, all of them different from those we here illustrate. All we can do is therefore to give some idea of the wealth of artistic electric light fittings here to be found, and advise our readers to visit themselves the showrooms in Covent Garden.

CHATHAM.

At a meeting of the Chatham Local Board of Health on Friday morning, a notification was received from the Chatham and Rochester Electric Lighting Company that the Board of Trade was empowered under a recent Act to exercise certain jurisdiction over companies having no provisional order, and they, the Board of Trade, required the companies to put the wires underground. In order to obtain the necessary powers to place the wires under ground, the company had decided to apply for a provisional order, which would give them power to break up the public streets in Chatham and other places. The Clerk reported that it was necessary for plans to be before the Board before they could give consent to the provisional order. Mr. Taylor said that other Boards had given their consent without having plans. Mr. Randall said that was because the other Boards had not the experience of the Chatham Board. Mr. Church, as a user of the electric light, said if they waited for plans they might have to wait years, as the company could not tell where the wires would have to go. The Clerk said the Board of Trade would require plans. Mr. Taylor said it would be a great improvement if the wires were put underground. He thought they should do all they could to help the company, and pointed out that they did not require plans from the gas company. The Clerk said that other things besides the putting of wires underground would be obtained by the provisional order. Mr. Taylor said he should propose that consent be given; to refuse consent would be standing in the way of public improvements. Mr. Church said he should second it. Mr. Randall said they must have the plans. Mr. Taylor asked, as the company could not tell who was going to have the electric light, how they could produce plans as to where the wires were going. Mr. Randall said they had a professional gentleman as clerk, and he had given his advice that they must wait until they received the plans. The Clerk said he did not wish to take the responsibility; the company might obtain many other powers under the provisional order. Mr. Church said, if it meant other things he should certainly withdraw his proposition, but if it was merely to obtain permission to go where customers required the light, it would be standing in the light of public improvements to object to it. Mr. Randall said Mr. Church was a shareholder, and ought to know what it was the company wanted. Mr. Church said he did not know; he was simply looking at the matter from a business point of view. The Clerk said he was solicitor to the company as well as clerk to the Board, and he was bound to give the advice he had given. The proposition was then withdrawn, and on the motion of Mr. Randall, seconded by Mr. Buck, it was resolved to have a copy of the proposed provisional order before discussing the matter further.

LEGAL INTELLIGENCE.

THE UNITED TELEPHONE COMPANY'S PATENTS.

An action of the United Telephone Company, Limited, v. Ahern and Co., came before Justice Kay on Saturday as a short cause, the defendants not having appeared.

Mr. Micklem appeared for the plaintiffs, and said the action was brought on two patents, the Edison and Bell, and the statement of claim stated that the validity of these two patents had come in ques-

tion in a previous action, and had been established, and certificates granted. With the statement of claim had been delivered particulars of breaches, setting out the various acts of which the plaintiffs complained, and the order asked for was that the defendants might be restrained from manufacturing, selling, supplying, or using any of the telephone transmitters mentioned in the particulars of breaches or any other instruments constructed according to the specification named.

Justice Kay said he could not grant the injunction in that form, the defendants not appearing. He did not think the particulars of breaches formed part of the pleadings, and therefore he could only grant an injunction restraining the defendants from infringing the patents mentioned in the statement of claim.

Mr. Micklem said the minutes further asked an order that the defendants do, within seven days from service of the order, deliver up on oath all infringing instruments in their possession, or under their control, for an enquiry as to damages, and an order that the defendants pay such damages within 14 days after certificate, and all costs, charges, and expenses as between solicitor and client, according to section 31 of the Patent Act of 1883.

His Lordship made the order in this form.

PHYSICAL SOCIETY.—June 22.

Prof. REINOLD, F.R.S., President, in the Chair.

Major P. Cardew, R.E., and Mr. A. W. Ward, M.A., were elected members.

The following communications were made:

"Note on some Photographs of Lightning and of 'Black' Electric Sparks," by Mr. A. W. Clayden. The lightning photographs, three in number, were obtained during the storm on the 6th inst. Two flashes seen on one plate show a complicated and beautiful structure. One of them is a multiple flash, and flame-like appendages point upwards from every angle. The other is a broad ribbon, and, although the plate shows signs of movement, the displacement is not in a direction such as would produce a ribbon-like effect from a simple flash. The second plate shows four flashes, none of which are ribbon-like, though the camera had moved considerably. The third plate was exposed to six flashes, one of which was believed to pass down the middle of the plate, but on development only a triple flash in one corner of the plate was seen. Careful search, however, revealed the central flash as a dark one with a white core, and other dark flashes were subsequently found. The plate was very much over-exposed, and this suggested that black flashes might be due to a sort of cumulative action caused by the superposition of the glare from a white cloud upon the normal image of the flash. To test this, sparks from a Wimshurst machine were photographed, and before development the plates were exposed to diffused gaslight for a short time. The bright sparks yielded normal images with reversed margins, and the faint ones were completely reversed. Other experiments showed the reversal to spread inwards as the time of exposure to gaslight increased. Finally, reversal was effected by placing a white screen behind the spark to represent a white cloud, the only illumination being that of the spark itself.

In the discussion which followed, **Mr. W. N. Shaw** exhibited a photograph taken during the same storm, which is particularly rich in dark flashes, branching outwards from an intensely bright one. In some places the bright line has dark edges, and in one part a thin bright line runs along the middle of an otherwise dark portion of the flash. In answer to Mr. Inwards, Mr. Shaw said the plate was exposed about half a minute, and the former thought that under those conditions, the appearance of the plate did not contradict Mr. Clayden's hypothesis.

Speaking of the same photograph, **Prof. Perry** considered that Mr. Clayden's observations would explain the result, for a bright flash required more exposure to diffused light to reverse it than a faint one did.

Prof. Ramsay reminded the meeting that Prof. Stokes's "oxides of nitrogen" explanation was still a possible one, and **Mr. C. V. Burton** asked whether they may be due to faint sparks cutting off light from brightly-illuminated clouds, just as a gas flame absorbs light from a brighter source.

In reply, **Mr. Clayden** thought the "oxides of nitrogen" hypothesis improbable, and said his experiments did not enable him to answer Mr. Burton's question. As regards Mr. Shaw's plate he believed the diffused light from the clouds would be sufficient to reverse the fainter tributary flashes, although it was insufficient to reverse the primary one. From data obtained when the ribbon-flash was taken, he had made some calculations which gave the height of the clouds about 1,000 yards, and the ribbon-flash 1,300 yards long and 100 yards wide.

"Researches on the Electrical Resistance of Bismuth," by Dr. Ed. von Auel. The paper, which is in French, was taken as read. A translation will appear in the *Proceedings* of the society.

"Expansion with Rise of Temperature of Wires under Pulling Stress," by J. T. Bottomley, M.A., F.R.S. The investigation was to determine whether the coefficient of expansion of wires depends on the stress to which they are subjected, and was undertaken in connection with the secular experiments on the elasticity and ductility of wires, now being conducted at Glasgow University. Two wires, about 17ft. long, of the same material, were suspended side by side, within a tube through which steam could be passed to change the temperature. One wire was loaded to half, and the other to one-tenth its breaking weight, and in the preliminary experiments the elongations were read by a Quincé microscope cathetometer. About 150 heatings and coolings, extending

over three months, were necessary to bring the heavily loaded wire to its permanent state, so that consecutive expansions and contractions were equal. When this stage was arrived at, hooks of peculiar shape were attached to the lower ends of the wire. These hooks form a relative geometrical guide, and their horizontal parts mutually support a small table which carries a plane mirror. If the wires expand or contract unequally, the mirror becomes tilted, and the relative displacement is observed by means of a telescope and scale fixed nearly vertically over the mirror. From experiments on copper wires, the coefficient of relative expansion was found to be 0.32×10^{-6} per degree C., or about $\frac{1}{3}$ of the ordinary linear expansion of the material. The heavily loaded wire expanded most. The results for platinoid give 0.27×10^{-6} as the relative coefficient under the conditions named above; this is about $\frac{1}{4}$ of the ordinary linear expansion, which from separate experiments was found to be 15.4×10^{-6} .

Mr. H. Tomlinson thought the probationary period for copper might be considerably shortened by repeatedly putting on and taking off the load, and by subjecting the wire to torsional oscillation. With iron wires this would not be the case, for they behave in a most peculiar manner, and require long periods of rest after each oscillation. From experiments he had conducted during the last two years, he found that the permeability of iron could be enormously reduced by repeated heatings and coolings whilst undergoing magnetic cycles of small range.

Mr. Gregory said the paper threw considerable light on some experiments on the sag of stretched wires upon which he was engaged. He also suggested heating the wires by electric currents.

In reply, **Mr. Bottomley** said he had considered it important to leave the wires untouched after being suspended, and as regards heating by electricity, he thought that convection currents would make the temperature non-uniform.

Owing to the absence of **Prof. S. P. Thompson**, his "Notes on Geometrical Optics" were postponed.

COMPANIES' MEETINGS.

SOUTH OF ENGLAND TELEPHONE COMPANY.

The ordinary general meeting of this Company was held on the 27th ult., at Winchester-house, Old Broad-street.

Mr. D. Owen Bateson presided, and in moving the adoption of the report, observed that the expenditure on capital account was in excess of that of last year by £3,460, owing, in great measure, to the increase in business—namely, 451 exchange and 114 private lines—resulting in a substantial increase in the gross rental of the Company. They had also spent a good deal of money on trunk lines in their district, in joining up the several towns in which they had exchanges, and gradually connecting them together, so that when the good time came which they had been so long expecting, when they would be admitted into London, only short lengths would be required to enable them to join hands to the metropolitan system. The revenue of £18,792 showed an increase over that of last year of £4,928; but they were obliged to transfer £9,041, which was an increase of £2,070, to the present year, the great activity in their business being in the summer. This amount would, however, be for disposal during the year just entered upon. The large sum they had paid for royalties, £3,455, was a very heavy tax on them, really amounting to 7 per cent. on their paid-up capital. In an able letter from the United Company to the Secretary of the Post Office that company had suggested that the public would be better served if the heavy tax imposed by the Post Office upon telephonic communications were removed. Upon that he would venture to suggest that it would be an additional service to the public were the large royalties levied by the United Company on the subsidiary companies abolished, or at least materially modified. Were that done, it might strengthen the hands of the United Company in any negotiations with the Post Office, and it would certainly be a good example for the department to follow. Since their last meeting they had obtained a quotation on the Stock Exchange. The long-standing dispute with the United Company had been settled, and the invidious memorandum inserted by the auditors in their former balance-sheet had been eliminated this year. They had succeeded in reducing the claim from £1,845 to £1,265. The demand from their customers for trunk lines continued, but as yet the United Company had not seen fit to grant them any facilities in connecting their district with the metropolitan system. He understood that the United Company were running lines through the South of England Company's district, as under the agreement they had the power to do, with the intention of connecting up Birmingham in one direction and Bristol in another; but why the United Company were willing to grant accommodation to these distant towns and refused it to places contiguous to their own centre and to parties, many of whom were already subscribers to the London exchange, was a matter he could not understand. He thought it would have been only ordinary courtesy had their views been asked for before the lines run through their district by the United Company had been decided on. Some hard words had been used with reference to the treatment experienced by other companies from the Post Office. He could only state, as regarded their own Company, that they had always received the greatest courtesy at the hands of the department, with which they had always worked without the least friction. They knew very well the terms upon which they held the license, and though those terms were onerous enough they had never tried to go behind or beyond its requirements. The dividend proposed of 1 per cent. on the ordinary shares was $\frac{1}{2}$ per cent. more than that of last year.

Mr. A. MacGregor seconded the motion, which was adopted, and the dividend was afterwards approved.

CITY NOTES.

West Coast of America Telegraph Company.—The receipts of this Company for the month of June amounted to £6,500.

Direct Spanish Telegraph Company, Limited.—The receipts of this Company for June show a decrease of £90 as compared with the corresponding period last year.

West India and Panama Telegraph Company.—The receipts of this Company for the half-month ended June 30th were £2,750, against £2,578.

Eastern Telegraph Company.—The receipts of this Company for June were £44,805, as against £48,096 for the same period of 1888, or a decrease of £3,291.

Eastern Extension Telegraph Company, Limited.—This Company's receipts for the month of June were £39,350, as against £41,764 for the same period of 1888.

Western and Brazilian Telegraph Company, Limited.—The traffic receipts for the week ended June 28, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,017.

NEW COMPANIES REGISTERED.

Birmingham House-to-House Electricity Company, Limited. Registered by Slaughter and May, 18, Austinfriars, E.C., with a capital of £100,000 in £5 shares. Object: To form centres in Birmingham and elsewhere in the United Kingdom, at which electric power may be generated or accumulated, and from which the same may be distributed by means of wires or other conductors of electricity, for the purpose of lighting private houses, buildings, shops, factories, or works, or for the purpose of giving motive power for telephonic purposes, etc. The first subscribers are:

	Shares.
R. Hammond, 117, Bishopsgate-street, E.C.	1
C. Cornish, 132, Belvedere-road, S.E.	1
J. Whitehead, Crouch End, N.	1
T. E. Towerson, 1, Portland-road, Finsbury Park, N.	1
H. Bingham, 7, Bedford-place, W.C.	1
H. Linklater, 117, Bishopsgate-street, E.C.	1
H. Mann, 2, Woburn-place, W.C.	1

There shall not be less than three nor more than seven Directors. Qualification, £250 stock. The first to be appointed by the subscribers to the memorandum of association. Remuneration, £500, divisible, and one-tenth of net profits after 7 per cent. dividend.

Irish House-to-House Electricity Company, Limited.—Registered by Slaughter and May, 18, Austinfriars, E.C., with a capital of £100,000 in £5 shares. The objects of the Company are similar to the above, and the subscribers to the memorandum of association the same. All the other conditions with regard to qualification and remuneration are also identical.

Lancashire and Cheshire House-to-House Electricity Company, Limited.—Registered by Slaughter and May, 18, Austinfriars, E.C., with a capital of £100,000 in £5 shares. The objects of the Company are similar to the above, and the subscribers to the memorandum of association the same. All the other conditions with regard to qualification and remuneration are also identical.

Electric Trust, Limited.—Registered by Hughes, Masterman, and Rew, 59, New Broad-street, E.C., with a capital of £60,000, in £10 shares. Object: the construction, contracting for, establishment and carrying on of works, machinery and apparatus for lighting streets, etc., by electricity. The first subscribers are:

	Shares.
M. Chadwick, 17, Parliament-street, S.W.	200
H. L. King, Founders' Hall, St. Swithin's-lane, E.C.	200
J. K. D. Mackenzie, 15, Great George-street, S.W.	200
C. E. Masterman, Rye Bank, Alsager, Cheshire	200
H. C. Masterman, 59, New Broad-street, E.C.	200
W. R. Renshaw, Kidsgrove	200
E. R. Robson, 9, Bridge-street, S.W.	200

There shall be, until otherwise determined, eight Directors. Qualification, £2,000 stock. Remuneration, £50 each.

Northern Electric Wire and Cable Manufacturing Company, Limited.—Registered by Godfrey, Rhodes, Firth, and Co., 77, Chancery-lane, W.C., with a capital of £20,000 in £5 shares. Object: to carry into effect an agreement, dated June 20, made between Blakey, Emmott and Co., Limited, and J. Duff, and to carry on the business of insulated wire and cable manufacturers. The first subscribers are:

	Shares.
E. Fowle, The Hall, Lapley, Staffs.	1
E. Blakey, The Grange, Lightcliffe	1
W. Emmott, Square-road, Halifax	1
W. Levi, 52, Hyde-park-road, Halifax	1
W. S. Smith, 70, Crown-street, Halifax	1
W. Gantinger, Fernside, Halifax	1
G. Rhodes, Ashfield, Sowerby Bridge	1

There shall not be less than three nor more than five Directors. The first to be appointed by the subscribers to the memorandum of association. Qualification, 100 shares. Remuneration: £2. 2s. for every attendance for each Director residing within 90 miles of the place of meeting, and £4. 4s. when residing more than 90 miles. Every Director is also to receive £20 for every 1 per cent. of dividend above 10 per cent.

Series and General Electric Traction Company, Limited.—Registered by Norton, Rose, Norton, and Co., 10 Victoria-street,

S.W., with a capital of £200,000, in £1 shares. Object: to acquire the patents, property, goodwill business, undertaking, and assets of the Series Electrical Traction Syndicate, Limited, or any part thereof, and certain patents or rights or interests therein, belonging to H. Foote and C. Von Buch. The first subscribers are:

	Shares.
A. E. Gathorne-Hardy, M.P., 22, Charles-street, Berkeley-square	300
Lient.-Colonel O. M. Davidson, 11, St. George's-square, S.W.	300
Lient.-Colonel E. J. Fryer, 22, Ryder-street, W.	300
T. R. Greenhill, 1, Brownswood-park, N.	1
W. A. Norton, 111, Foulden-road, N.	1
E. F. Lamb, 14, Victoria-street, South Hackney	1
J. P. Scott, 38, Muchelver-road, Lea, S.E.	1

There shall not be less than four nor more than 12 Directors. Qualification, 300 shares. Remuneration: Chairman, £500; other Directors, £250 per annum.

PROVISIONAL PATENTS, 1889.

JUNE 24.

10263. **Transmitting signals to or from a locomotive engine by the aid of electricity.** John Gardner and Thomas Ridley Sowerbutts, 14, Lower Bank-road, Fulwood, Preston, Lancashire.

JUNE 25.

10295. **Improvements in telegraphy.** William Phillips Thompson, 6, Lord-street, Liverpool. (Charles Goodwin Burke, United States.) (Complete specification.)

JUNE 27.

10412. **Improvements in electric railway cars, and in underground conductors and appliances for the same.** Joseph John Butcher, 919, Tatnall-street, Wilmington, Delaware, United States.

10440. **Improvements in holders for incandescent electric lamps.** Henry Bayley, 55 and 56, Chancery-lane, London.

10461. **Improvements in electrical signalling apparatus.** Herbert Brocklehurst and Henry Constein, 35, Southampton-buildings, London.

JUNE 28.

10517. **Improvements in elements for voltaic batteries.** Edward Frankland, Nevil Story-Maskelyne, Arthur Henry Hough, and Desmond Gerald Fitz-Gerald, 47, Lincoln's-inn-fields, London.

10519. **Improvements in electro-motors.** Edward Crozier Sibbald Moore, 24, Southampton-buildings, London. (Ross Franklin Moore, India.)

JUNE 29.

10556. **An improved manufacture of flexible electric cable.** William Ernest Gray, 6, Bream's-buildings.

SPECIFICATIONS PUBLISHED

1883.

5955. **Carbon filaments, &c.** Zanni and Shippey. 8d.

1888.

8170A. **Electric shunting device.** Allison. (The Baxter Electric Manufacturing and Motor Company.) 8d.

9171. **Electric lighting.** Langdon. 11d.

9747. **Electric bells.** Winnall. 8d.

10194. **Electrical switches.** Cockburn. 8d.

10363. **Mutiple telegraphy.** Mercadier. 1s. 5d.

10956. **Electrical lighting apparatus.** Smith (Nachfolger.) 8d.

13994. **Electric circuits.** Kendall and Cooper. 8d.

1889.

6064. **Electro-magnets, &c.** Lake (Thomson). 8d.

7356. **Galvanic batteries.** Maltby-Newton. 6d.

7619. **Electric batteries.** Barber-Starkey. 6d.

7645. **Electrical conductors.** Cook. 8d.

7647. **Electric motors, &c.** Wheeler. 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.	Name.	Paid.	Price Wednes- day
12 Feb. 1/2	Anglo-American Brush E.L.	4	3 1/2
12 Feb. 2/0	— fully paid ..	5	4 1/2
14 Nov. 0/4 1/2	Con Telephone & Main ...	1	8
27 July 10/0	India Rubber, G. P. & Tel.	10	19 1/2
.....	House-to-House	4 1/2	4 1/2
30 May 2 1/2%	Oriental Telephone	11	1 1/2
.....	London Electric Supply ...	5	3 1/2
.....	Swan United	3 1/2	3 1/2
12 July 12/0	Telegraph Construction ...	12	42 1/2
2 July 6/0	— 6% 1889	100	105
29 Nov. 5/0	United Telephone	5	15

NOTES.

Norway.—The question of lighting the silver mines of Kongsberg, which belong to the Government, is under consideration.

From Above to Below.—The work of transferring the overhead wires of the Grosvenor Gallery installation to conduits under the street is being carried out.

Personal.—Add to the list of representatives given in our last issue Mons. Th. Pilster, 24, Rue Alibert, Paris, who represents Messrs. John Fowler and Co., of Leeds.

The Exhibition.—It is said that three alarms of fire have been caused by contact of the electric light wires at the Exhibition. In each case it seems to have been caused by sheer carelessness.

Noteworthy.—In the telephonic amalgamation Mr. Brand gracefully declines the chairmanship, and Mr. Morgan is not appointed to any executive position. A good many people have been asking "Why is this thusly?"

Fountains.—Just as the brilliant display produced by the illuminated fountains at the Kensington Exhibition proved one of the most attractive daily features, so does the illumination of the fountains at the Paris Exhibition.

Maidstone.—Mr. Webster, the inventor of the electrolytic treatment of sewage by electricity, has been visiting Maidstone with a view to the formulation of a scheme for the purification of the River Medway, which is now very much polluted by sewage.

A Go-a-head Town.—Peoria, Illinois, is laying itself out for big things. It is going to spend 200,000dols. on an electric railway as well as 1,000,000dols. on water works in order to bring an access of population, and expects within five years to number 100,000 people.

Personal.—We regret to notice in our contemporary, the *Electrical World*, a report that Mr. Henry Edmunds, so well known to many of us, has been very ill with pneumonia while in New York, but we are glad to say that the latest report is that he is much better.

Electric Omnibus.—Mr. Ratcliffe Ward and Mr. F. B. Behr have exhibited Ward's electrical omnibus to the Shah in the grounds of Buckingham Palace. His Majesty seemed greatly interested in the performance of the omnibus, which moved and turned round with ease and precision.

Meters.—The committee nominated by the City of Paris to examine into the merits of electric meters, has commenced the work entrusted to it. The competitors are twenty-seven in number, although only eighteen have sent actual apparatus. The remainder have sent drawings and photographs.

Preservation of Milk.—M. Maisonhaute, having noticed that the passage of an electric current retards the formation of the cream, thought treatment by electricity would be favourable to preservation. A number of experiments have been carried out to see if this was the case, and the result has been very satisfactory.

Woolwich.—Commander Batten, chief of the Electric Light Department at the Admiralty, was busy during the last three or four days last week in testing the electric light apparatus which has been fitted on the gun wharf and on board the new vessels "Warspite," "Rodney," and

"Australia." The trials have proved in every way satisfactory.

Water-Gas.—In discussing the question of water-gas and its applications, Max Geitel, in a recent number of *Glasser's Annalen*, calls attention to the various attempts that have been made to obtain illuminating gas by the electrolysis of water, and suggests that with the great advance of the last few years in electric science such electrolytic decomposition may contain possibilities even now undreamed of.

Lisbon.—The work now being carried out at the Lisbon Docks is carried on with greater expedition because at night it is lighted by means of the electric light. Each of the seven floating stages which are used to construct the foundation walls of the quay carry a combined dynamo and Parsons engine. The workshops are lighted by means of the Jablochhoff candles, which receive the current from two Gramme machines.

Manchester.—A special meeting of the Manchester City Council, in pursuance of the Electric Lighting Act, 1882, will be held on the 7th August to take into consideration and determine upon the expediency of applying to the Board of Trade for a provisional order in accordance with the Electric Lighting Acts of 1882 and 1888 to authorise the supply of electricity by the Corporation for public and private purposes within the city of Manchester.

County Councils.—The position of County Councils in relation to electric lighting will be gradually defined as powers are asked for by companies or local authorities. It was stated in the discussion of an application—addressed wrongly, however, to the Bucks County Council—that if posts and wires had to be put up by the sides of the roads it would be a matter for the Highways Committee to look into, and we presume this would be so in all cases where the roads were under the jurisdiction of the County Council.

Tatham's Cables.—These cables, as manufactured by Messrs. Fowler and Co., have had very successful trials at Eastbourne, where placed underground, and with fairly high voltage; and at St. John's Colliery, Normanton, where great difficulties have been encountered owing to water constantly running down 300ft. of the wires, that is from the top of the shaft to the bottom, all difficulties ceased on using these cables. No trouble, again, has been given at Leeds. As experience, therefore, accumulates, it is very favourable to this system for underground work.

The "Journal."—Generally, when the electrical papers speak of the *Journal*, they refer to the *Journal* of the Institution, but in this case we refer to the *Journal* of past and present students of the City and Guilds of London Institute, number 4 of which is before us, and contains a number of shorter or longer articles of a character no doubt very interesting to the students, and some of them to outsiders. One short paper, in particular, commends itself to us. It is entitled, "My First Lecture," the author unknown, but whoever he is he ought to make his mark.

Sewage Precipitation.—Last week at the London County Council Mr. Rhodes (chairman of the Main Drainage Committee) submitted the report of the committee, which stated that in connection with the experiments about to be carried out by Mr. W. Webster, at Crossness, for the precipitation of sewage by electricity, it would be necessary for the Council to engage temporarily the services of an electrician, and having conferred with the chemist, they recommended that Mr. J. N. Shoolbred, of No. 1, Westminster-

chambers, be engaged for this purpose during the month of July.

Electric Lighting.—A Parliamentary paper, price 5½d., has been issued, giving a return containing the copy of a report made by Major Marindin after his enquiry, held by direction of the Board of Trade, into the various applications for provisional orders and licenses under the Electric Lighting Acts, in respect of the metropolis, as well as into the subject matter of a Bill introduced into the House of Commons by the Metropolitan Electric Supply Company, Limited, together with a copy of correspondence between the Board of Trade and the London County Council on the subject.

The Edison and Swan Company.—We understand that the directors had the accounts for the year ended June 30 before them on Tuesday, and that, subject to audit, they decided to recommend, at the meeting of shareholders to be held on 30th inst., a dividend of 7 per cent. for the year on the A shares, and a further distribution of 3 per cent., against arrears of cumulative preferential dividend on those shares. Certainly the shareholders are to be congratulated at this position of affairs, and it is a most decided proof of the wisdom and care with which the directors have managed the affairs of the company.

De Beers Mine.—This well-known mine at Kimberley is now lighted by electricity. The installation has been erected by Mr. R. O. G. Drummond. The engine used is a 10 h.p. of the compound condensing type by Fowler, and works at 130lb. pressure. The first trial of the engine was for 27 hours without stopping; since then it has run 150 consecutive hours each week, the lamps being lighted from Sunday night to the following Sunday morning. The dynamo is of the Manchester type by Messrs. Mather and Platt, and runs at 940 revolutions per minute. The main cables are 1½ in. in diameter, insulated with indiarubber, with an outer covering of tarred hemp braided.

Overhead Wires.—The *Liverpool Courier* says: Electric light and motive power cables add to the disfigurement of our streets, if not to the public danger arising from overhead wires. Provided an electric wire snapped as it came down it could do no damage by its current, for that would be shut off, but there may be cases where such wires come to the ground without breaking. The time must come in our great cities when all telegraph, telephone, and electricity-supplying wires shall be underground, but to carry out this reform at once would be a costly operation. Some time ago steps were taken along Broadway, New York, to put all such wires underground, but there the nuisance had become stupendous. As many as 150 wires were carried from pole to pole, and when snow accumulated there was serious interruption to communication.

The Palace of Industry.—This hall, so well known to most of our readers as being the scene of the Electrical Exhibition in 1881, has for some time been empty, but it has now been fitted up for a series of fêtes to be given during the duration of the large exhibition. The electric light installation has been carried out by the Continental Edison Company, and is said to be very effective. It comprises 1,000 incandescent lamps, 40 large arc lamps, and 186 smaller ones. The current to the incandescent lamps is supplied from an Edison station in the Palais Royal. The current for the arc lamps, which are of the Pieper and Pilsen system, is obtained from two Edison dynamos giving 400 amperes and 110

volts, and four dynamos giving 160 amperes and 150 volts, together with a battery of accumulators of 450 elements divided into three series.

Paris Conferences.—The International Society of Electricians has convened its members to a series of walking conferences at the Exhibition. The conferences are personally conducted. The first was under the auspices of M. D. Napoli, on "Measuring Instruments." That on the 9th was upon "Accumulators" by M. Sarcia. On the 18th inst. M. E. Hospitalier will expatiate upon "Commercial Measuring Instruments." On the 23rd "Military Telegraphy," etc., by Captain de Place. On the 30th upon "Motors and Transmission of Power," by M. A. Hillairet. On August 1 upon "Telephony," by M. R. de la Touanne. On August 6 upon "Continuous-Current Machines," by M. R. Arnoux. On August 8 upon "Electricity applied to War," by M. P. Lemonnier. On August 13 upon "Alternate-Current Machines," by M. R. V. Picou.

Bedford and Taunton.—The following letter has been received by the secretary of the Taunton Electric Lighting Company, Limited, from Sir Frederick Bramwell, C.E., F.R.S.: "2nd July, 1889.—Sir,—The Corporation of Bedford have asked me to advise them upon the subject of electric lighting in that town. From an interview I have had with the committee, it appears they were much impressed with that which they saw of the work done in electric lighting at Taunton by your company. I should be glad if you will allow me or my principal assistant, Mr. Harris, or probably both of us, to visit your works with the object of becoming personally acquainted with that which is being done in Taunton.—I am, sir, your obedient servant (signed) **FREDERICK BRAMWELL.**" Such a letter as this must be gratifying to Messrs. Laing, Wharton, and Down, the agents of the Thomson-Houston system in this country.

Electric Shooting.—Some very sharp shooting came off a little while ago by one of our correspondents on the African coast. Two Arab chiefs had come down from Yemen to Aden, and a trial ensued in which the Arabs, who were crack shots with their long guns, came off quite the best. Our Englishman resolved on a surprise to these gentlemen, and invited them to a grand test on the morrow. Meanwhile he prepared a fulminating fuse, laid a couple of insulated wires to a point on the sand hills some quarter of a mile away, carefully placed the fuse, covered it with sand, and on this placed a small glass bottle. On the morrow the Arabs were invited to fire at the minute speck in the distance. They fired half-a-dozen times, naturally far wide of such a mark. Our marksman then took his place, his attendant (with his hand on the key) being not far off. That bottle burst into thousands of fragments at the first shot, and the Arabs left with the most awestruck idea of the wonderful skill of the Englishman.

United Telephone Company's Patents.—The action of United Telephone Company, Limited, v. Liver- sedge and Company was heard on Saturday before Mr. Justice North in the Chancery Division of the High Court of Justice. Mr. Wicklem said the action came on upon motion for judgment in default of defence. The action was brought for an injunction to restrain the infringement of the Edison transmitter and the Bell receiver, and the claim asked that the infringing instruments might be delivered up to the plaintiffs. With the statement of claim particulars of breaches were delivered, and he

asked for an order in the same terms in which the courts had previously made them, with costs up to judgment, the costs of the enquiry as to damages being reserved. His lordship made the order as asked. A similar order was made by Mr. Justice Chitty in an action of the United Telephone Company *v.* Brierley, which was heard as a short cause, the defendant not appearing.

Business Progress.—Last week we described and illustrated some of the electric fittings designed and made by Messrs. B. Verity and Sons, of Covent Garden, who have done a good deal of electrical work the last year or two, and recently have been exceedingly busy in electric lighting work. Some of the most important works they have in hand are the following, viz: Sberborne House, as well as the church on the estate, Northleach, Gloucestershire, for Captain L. Byng, Royal Horse Guards; Footscray Place, Kent, for Sir John Pender, K.C.M.G.; Riverhome, Hampton Court, as well as the beautiful Swiss chalet on the river bank, for Osborne O'Hagan, Esq.; the Commercial Bank of Scotland, City; and five mansions in London and Brighton for connection to central stations. The firm are also busy in the manufacturing departments, having secured the whole order for fittings for the Government House, Singapore, Straits Settlements. Messrs. B. Verity and Sons have added to their catalogue upwards of 140 new designs in copper standards, brackets, etc.

Country Telegraph Offices.—Mr. Fellowes asked the Postmaster-General the other evening what were the rules regulating the establishment of telegraph offices in country districts; whether a parish of 1,300 inhabitants, within half a mile of main wires and with parishes round comprising over 2,000 inhabitants, was to be put to the inconvenience and expense arising from the want of a telegraph office; and whether the finding of a sufficient guarantee in a poor parish being found to be impossible, he would take into his further consideration the possibility of establishing a telegraph office at Sawtry, Hunts. In reply, the Postmaster-General said, "I have to state that the rule laid down by the Treasury in regard to the establishment of telegraph offices is that, if it is estimated that the revenue will not cover the expenses of the office, a guarantee must be given to secure the Post Office against loss. The main wires to which the hon. member refers cannot be made available for serving a telegraph office at Sawtry. It would be necessary to erect a new wire nearly seven miles in length, and I regret to say that it is not in my power to provide this wire and open a telegraph office unless a guarantee of £32 a year be given."

Government Purchase.—Mr. Campbell-Swinton, writing to the *Financial News*, among other things says: "The only really practical issue is, therefore, a monopoly embracing the whole country, and, from the public point of view, the question is whether such a monopoly should best be entrusted to the Post Office or permitted to remain in the hands of a private company. Doubtless there is much to be said for and against each of these two alternatives, but, considering the close alliance there exists between the telegraph and the telephone, and the great convenience that would result were they worked in connection, it would surely be to the public advantage that they should be both in the same hands and under the same control. The State purchase of the telegraph may, or may not, have been a mistake; but seeing that is a *fait accompli*, it seems that a similar proceeding with regard to the telephone must sooner or later follow, and the present appears to be a

favourable opportunity for considering it. It should be understood, however, that the telephone systems which the State may eventually have to purchase are what are known as the public exchange systems only, for the vast, and at present quite unimagined, extension of telephony for private line and domestic purposes, which will commence in two years' time, when the Bell and Edison patents have expired, and telephone instruments can be purchased outright for as many shillings as they now cost pounds per annum for rental only, will manifestly be far better left always to private enterprise and competition.

The Short System.—According to Mr. S. H. Short, the line in St. Louis equipped with his system has been running five trains of two cars each, which during thirty days covered 16,590 miles, 1 per cent. of time having been lost in repairs, and that the cost of operation for motive power, including repairs, was 2.59½ dollars per car day of 20 hours. According to our contemporary, the *Street Railway Journal*, an interesting experiment to decide between an entire metallic circuit and a rail return was made on this line on the 30th of May. "After the electric road had stopped at midnight, a party of street railway men met Mr. Short at the power-house for the purpose of determining whether the current of electricity passing through the wheels of the cars to the track enabled roads using the rail return to carry heavier loads and climb steeper grades than where an entire metallic circuit was used. Mr. Short placed the road with its motor cars at the disposal of these gentlemen, and they made up a train of one motor car and six coaches for their experiments. With this train on the rails they connected one pole of the generator with the ground and one pole of the motors with the wheels of the motor-car, and commenced the ascent of a 3 per cent. grade with the current passing through the wheels to the rails. They were obliged, it is said, to stop and back, run for it, and stop again before they climbed the little hill. They then returned to the foot of the grade, and after connecting the line and motors up in their usual manner, again started for the hill. This time they climbed the grade without any difficulty, it is stated, and repeated the ascent with an additional coach at the rate of from six to eight miles an hour."

Chicago.—The Chicago correspondent of our American contemporary, the *Electrical Review*, has the following little tale about the doings of various people in Chicago: "Eternal vigilance is the price of safety in electric lighting as surely as it is the price of liberty in a nation. We had a case in point here the other day. It was a combination of curious freaks that produced the result. Firstly, an arc light company came along and ran its wires along the kerb wall under the sidewalk, all right and proper in front of an untenanted building. Next came along a lot of chaps with a corner on a bath system, in which hot air is substituted for hot water for parboiling patrons, and wanting all the room possible, they plastered in the arc light wires as solid as the Egyptians used to tie up their deceased relatives. The next number on the programme was the nailing of incandescent wire moulding directly over and into the arc light cables. Then the hot steamy air of the new fangled Turco-Russian hot-air-burn-you-till-you-sweat system worked its way into the woodwork, and made things damp enough so that a blaze was inaugurated by the escaping current. There were three "ifs," at least, that would have prevented the little burn, which, fortunately, cost little, but might, under other circumstances, have been much more expensive. If the company had been notified

of the intending covering of its wires by the plasterers, who knew no better; or if the plasterers had not covered them; or if the knights of the bath had not wanted to use incandescent lights; or if the incandescent man had not driven a nail at that exact spot; or if the air in the room had remained dry, there would have been no fire. And that is why I spoke about eternal vigilance as I did."

France.—The French Government, says the *Chamber of Commerce Journal*, has decided to take the telephone service into its own hands, and not to grant concessions to private companies. The Société Général des Téléphones has had a little tussle over what it considered to be valid rights conceded by a convention in July, 1886, and which would prevent the exercise of State control proposed. This convention, it would appear, ceded to the company the monopoly of telephone working for 35 years with power to the State to acquire by purchase in 15 years. In November, 1886, a convention was also drawn up on these lines and submitted for Parliamentary sanction, in this respect only differing from the earlier dated convention. Parliament refused to recognise this convention, and a special commission recommended the State taking over the system. The company contended, however, that by its earlier convention, which did not require Parliamentary sanction, they had the monopoly on the conditions above mentioned. On the other hand, on behalf of the Government, it was argued, in addition to certain questions as to whether the telephone system was or was not a public work of the nature to require Parliamentary approval, that the earlier convention of 1886 was of no value because the decree by which it was approved had not been promulgated either in the *Journal Officiel* or in the *Bulletin des Lois*, and, in spite of the signatures attached to the decree, "it is a document which has not legal existence, and which has, moreover, never been communicated officially to those interested." As there appears little chance of the Government altering its view, it will be entitled to take possession of the telephones started by the company under its concession of September, 1884, the period of which expires in September this year.

Parliamentary.—Bills have been printed embodying the provisional orders made by the Board of Trade, and granting powers to various companies to supply electricity in different parts of London. The Metropolitan Electric Supply Company, under their Bill, will light in South London the parish of Lambeth, and parts of Clapham and Streatham. In mid-London the area of supply consists of portions of the Holborn, St. Giles', and Strand districts, and in West London a large number of streets in the parish of Marylebone. The Electricity Supply Corporation, under their Bill, will confine their area of supply to the Strand and some other streets in the parish of St. Martin-in-the-Fields. The House-to-House Electric Supply will carry their system into Kensington, Knightsbridge, and Notting Hill. The London Electric Supply Corporation will supply the parishes of Chelsea, St. George's, Hanover-square, St. James's, Westminster, St. James and St. John, Clerkenwell, part of St. Martin-in-the-Fields, St. Margaret and St. John, Westminster, that part of Lambeth north of Westminster-bridge-road, St. Mary, Newington, St. Saviour's district, St. Olave's district, Rotherhithe, Bermondsey, and Greenwich. The various companies are prohibited from using overhead wires except by the authority of the County Council, and other restrictions are imposed as to

breaking up the roads, etc. They may make a charge for the electricity by the actual quantity of energy so supplied, or by the electrical quantity contained in such supply; or, unless the Board of Trade from time to time otherwise direct, by the number of hours during which the supply of energy is actually used by such consumer, and the maximum power with which he is for the time being entitled to be supplied. They must, however, state beforehand which method of charge they intend to act upon, nor must they change it except they give a month's notice.

Barnet.—The *Barnet Press* reports that at the last meeting of the Board the Clerk stated that he had not yet received any definite reply as to the period at which the electric light will be kept burning all night in the junction lamps. In reply to a fellow member, Mr. Schmidt said he could not say whether the new engine, which had been fixed at the electric light works, was now at work, but he knew that fires had been going in the new boiler. The Chairman said the boiler and engine were both fixed, but he did not know whether they were yet connected. Mr. Parsloe observed that he had noticed the light had been much better of late. The Chairman: How did you find it last night? Mr. Parsloe: Very good. The Chairman: When I came down Hadley Green at about eleven o'clock, I thought it was very bad indeed—something like the old times. Mr. Samuels: I attribute that to the position rather than to the power of the lamps; some of them are almost hidden by the foliage of the trees, but when you get beneath them you can see that the light is there all right. Mr. Schmidt said that was so. He would like the Lighting Committee to be requested to take that matter into consideration. At Mr. Parsloe's the light was very good, because the trees had been lopped so that the lamps were beneath the foliage, but on the opposite side of the way the reverse was the case. When the proper time arrived, the trees might be so lopped that the lamps would not be hidden: he did not believe this would spoil the trees in any degree. The Chairman said his remarks had reference to lamps that were not hidden by trees: the light was very bad indeed on the previous night. Mr. Parsloe agreed that something should be done in those cases where the lamps were at present hidden. Mr. Samuels said there was a report of the old Lighting Committee on the very point that was now being mooted; if the Board referred the question to that committee, it would doubtless be considered at their next meeting. It was agreed to refer the matter to the Lighting Committee.

Future Prospects.—Mr. Max J. Becker, president of the American Society of Civil Engineers, in his address to the society, referred to the future prospects of electrical engineering. He said: "Of the forces of nature, the one which has remained a hidden mystery longer than all the rest, but which of late has distanced all in the rapidity of its development, and which is certainly destined to excel them all in the extended range of its useful application, electricity stands pre-eminent. In the prosecution of subterranean or subaqueous operations, such as tunnelling, mining, sinking of caissons, the use of electric light is found to be of special benefit; in its incandescent form, it is absolutely safe against the dangers from explosive gases, and in caisson work it removes the risks and inconveniences incident to the ready and rapid combustion of inflammable substances under the influence of high atmospheric pressure." Proceeding to discuss street railways, he mentioned that:

"At the close of the past year, there were completed and in course of construction in America 85 electric railways, comprising about 450 miles of track, and the reports show that during the last year over 18,000,000 of passengers have been carried over these lines. The cheapness of original construction and subsequent maintenance and operation commend their adoption in smaller cities, where the older systems would be out of the question; and the practicability of their application in situations which could exclude cable lines and horse traction have led to their introduction in places like my own home, Allegheny City, where an electric railway is now in successful operation, which, in a distance of one mile out of a total length of four miles, ascends, with a speed of fully four miles per hour, a hill over 400ft. high, upon gradient of $12\frac{1}{2}$ per cent., with numerous curves of 40ft. radius, the cars being often loaded with 75 people. Upon the lower portion of this line the electric current is supplied by means of an underground current, and on the upper portion of the line by the ordinary overhead conductors."

Provisional Orders.—Anyone who, from choice or necessity, has consulted the reports of recent meetings of the various town councils, will find throughout the length and breadth of England that the report of the local papers contains some such paragraph as the following: "The town clerk stated that he had received five notices from electric lighting companies stating their intention to apply to the Board of Trade for provisional orders for supplying electricity in the city." The number five, however, is not always found. Six seems to be about the maximum, for this seems to be the number at Edinburgh, in other cases one or two; but there seems to have been from six distinct sources a portioning out of the kingdom, and a general posting of notices to the local authorities to the effect that provisional orders were going to be applied for. We can only mention a few towns where such application has been made. Thus at Worcester the notices were referred to the Watch Committee. At Kidderminster the notice was referred to the Law Committee. At Workington the letter was read, but we are not informed what was done with it. At Aldershot the reply was given that the Board had no objection, so long as the public rights of Aldershot and the inhabitants were respected. At Dover particulars were required. The Belgrave Local Board assented to the application. At Oxford, a considerable discussion took place, and the Chairman suggested that they should take no notice of these matters. Alderman Underhill, asked what would be the position in which they would be placed supposing the applications were unopposed, and one of the companies obtained an Act of Parliament for the purpose of lighting Oxford, and he referred to many cases where companies had obtained concessions and then would not go to work until the inhabitants had subscribed a certain amount of money. It was explained that the provisional order would have to be sent for their approval, and they would then be in a position to express their opinion upon it, and thus the matter rests. At Edinburgh the applications were referred to the Lord Provost's committee. The authorities, however, would probably consider the advisableness of the Corporation applying themselves. At New Malden the clerk is to report at the next meeting of the Board. But we might go on extending this list to almost any extent. As it is, our readers may take it for granted that the possibilities of introducing the electric light into the

districts under every local authority in England has been carefully considered by some one or other of these six companies, and if after consideration a favourable view was taken, the local authority has received a notice. We are glad to see that in many cases the authorities are disposed to consider what they themselves shall do in the matter.

House of Commons.—In the House of Commons, on Wednesday, on the order for the second reading of the Electric Lighting Provisional Orders (No. 2) Bill, Sir G. Campbell said he had no desire to stop the progress of these Bills; but he wished to be assured that the section of the Act of 1888 which provided that the consent of the local authority should be obtained before a provisional order was granted by the Board of Trade for the lighting of any district had not been forgotten. In the case of the Bills now before them, he complained that they were asked to read them a second time without having had an opportunity of considering the special report of the Board of Trade with regard to those orders in respect to which the objection of the local authorities had been overridden. Sir M. Hicks-Beach said that the Act of last session was properly stringent upon the point which the hon. member had raised. A special report had been duly framed, but owing to the printers' delay it was not ready for presentation to members. There was no special provision requiring that the report should be made to the House at any particular time, although he thought it would be right and proper that it should be in the hands of members before the second reading. He had had to deal with exceptional difficulties. The House was aware that a searching enquiry was held by Major Marindin into all the proposals for lighting the metropolis made by various companies for various districts overlapping one another, and sometimes made without the consent of the local authorities. It was only with the greatest possible difficulty that he had been able to frame provisional orders as the result of that enquiry at such a time of the session, when he hoped it would not be too late to pass them into law. He thought it was a great discredit to this country that the metropolis of this great Empire should not before this time have had the advantage of the electric light. He trusted that, while every proper interest would be safeguarded by the committee to which these Bills would be referred, it would be found possible during this session to deal with this matter, which might have been dealt with some time ago, but for defects in the general law. They had, before granting the provisional orders, made a very careful enquiry into the financial capacity of the various companies to carry out the powers with which they would be entrusted; and they were satisfied that they were justified in granting the provisional orders, with the belief that the powers would be carried into effect. The hon. member had referred to the objections of the local authorities which they had felt it their duty to overrule, as if those objections had been general. That was not the case. It would appear from the special report that in only two cases in the whole of the metropolis were objections made on any important grounds. The other objections were practically settled, and in the two cases which he had mentioned the objections were not based on matters of principle, but on matters of detail affecting clauses, which matters might be properly dealt with by the committee. He trusted that he might ask the House to forward this subject by giving a second reading to these Bills. The Bill was then read a second time, as were also three other Electric Lighting Provisional Order Bills.

ELECTROLYSIS OF BISMUTH SALTS.

BY ALEXANDER WATT.

(Continued from page 13.)

4. *Sulphates of Bismuth and Sodium.*—A solution of sulphate of bismuth, prepared as above, was added to a moderately strong solution of sulphate of soda, and the liquid afterwards diluted with about an equal quantity of water. With the current from a single Daniell cell, a brass plate quickly received a bright film of bismuth of a somewhat redder hue than in the foregoing experiment, but although the metal became dull after a time, it retained its reguline condition during a long immersion, and there was no further appearance of the black non-reguline metal, indicating that a solution of this constitution might probably be used as a bath for depositing the metal. There was no hydrogen evolved at the negative plate.

5. *Sulphate of Bismuth by Electrolysis.*—A solution of sulphuric acid was first prepared by mixing one part of the acid with seven parts of water. Into this liquid was placed a bismuth anode and a brass cathode, connected to a single Daniell cell. There was brisk evolution of hydrogen at the negative plate, and it was found that a film of bismuth formed on the surface of this electrode almost immediately after immersion, the respective plates being about a quarter of an inch apart. I cannot call to mind an instance in which a metal deposited so quickly under such conditions as in the present case. Tin enters very quickly into a solution of hydrochloric acid under electrolytic action, and deposits on the cathode with great rapidity, but scarcely so rapidly, I should say, as in the case referred to. After the plate had been immersed in the dilute sulphuric acid about a quarter of an hour, a dense black spongy mass formed on its surface, which rapidly spread—more especially in the direction of the anode—until it assumed considerable and bulky dimensions; at the same time a few large bubbles of hydrogen appeared at various parts of the spongy mass, and small flakes of metallic bismuth, probably reduced to the reguline state by the hydrogen, rose to the surface of the liquid, on which they floated.

6. *Chloride of Bismuth.*—A solution of this salt was prepared by digesting recently precipitated hydrated oxide of bismuth in moderately dilute hydrochloric acid, and the solution was afterwards diluted with a small quantity of water. With the current from one small Daniell cell, and small anode surface, a reguline deposit of bismuth was obtained, but after a short immersion the film assumed a dark colour nearly approaching to blackness. With the current from two cells, the metal deposited in a dense black mass, consisting of bismuth in a highly comminuted condition. This kind of deposit rapidly increased in bulk, and formed with increasing rapidity as it approached the anode.

7. *Chlorides of Bismuth and Potassium.*—A solution of chloride of potassium was first prepared, to which was added another of chloride of bismuth, and the solution was afterwards moderately diluted with water. With the current from one Daniell cell, a very prompt film of bismuth was obtained upon a brass plate, but this was quickly succeeded by the black spongy metal before noticed. The anode was now raised until a very small surface only entered the solution, and the negative plate was kept in motion for some time, under which conditions the metal deposited in the reguline form, and was found to adhere firmly to the brass surface. Further dilutions of the bath were next tried, the plate being allowed to remain stationary, when the metal deposited in a fairly good condition. A white subsalt formed in the anode, but there was no gas given off at the negative plate.

8. *Chlorides of Bismuth and Ammonium.*—A strong solution of sal ammoniac was first prepared, and to this was added a strong solution of chloride of bismuth. The concentrated liquid thus formed was next diluted with successive quantities of water, a freshly-prepared brass cathode being immersed in the solution after each addition. With the current from a single Daniell cell, a very prompt deposit of bismuth was obtained; but this was soon after succeeded by a black spongy mass, which, as before, grew

with great rapidity, while small bright metallic flakes rose from the mass, as before noticed, and floated on the surface of the liquid. The solution was next diluted with a weak solution of sal ammoniac (water alone causing a precipitate of subchloride of bismuth) when the character of the subsequent deposits greatly improved and assumed the reguline form. The film, however, which was always bright at first, soon became dull, and eventually black.

9. *Acetate of Bismuth by Electrolysis.*—In this experiment a quantity of acetic acid, containing about 15 per cent. of real acid, was placed in a glass vessel, and in the liquid was immersed a plate of bismuth and another of brass, connected to two small Daniells in series. The electrodes were placed about one inch apart. In rather less than a quarter of an hour a film of bismuth commenced to form on the negative plate, the metal being rather dark in colour and dull. It was, however, reguline, and the surface was readily brightened by rubbing with the finger. After a further immersion of about an hour the plate became fairly coated with metal, but it still appeared dark in colour and very dull. It was, however, readily brightened by scratch-brushing, when the film assumed the characteristic reddish hue. The anode remained perfectly clean.

10. *Citrate of Bismuth by Electrolysis.*—In this, as in the former case, it was desired to ascertain whether the bismuth anode would become freely acted upon by the vegetable acid solution under the influence of the electric current. For this purpose a strong solution of citric acid was first prepared, a bismuth anode and brass cathode being used as before. The current from two Daniells in series was used, under which conditions the brass plate became coated with a slight film of metal in about half an hour after the immersion of the electrodes. The plates being allowed to remain in the liquid undisturbed for an hour or so, a bright reguline film of metal formed upon both sides of the cathode, while it was noticed that there was no disposition for the metal to assume the black spongy condition so frequently observed with many other bismuth solutions.

11. *Chloride of Bismuth by Electrolysis.*—A solution of hydrochloric acid was first prepared by mixing together one part of the acid and two parts of the water. In this solution was immersed a bismuth anode and brass cathode as before, the current from a single Daniell being used. Under these conditions a film of bismuth began to form upon the cathode within two minutes after immersion of the plates, and very soon after the deposit assumed the black spongy condition on the surface of the reguline metal. This spongy metal continued to increase in substance very rapidly, until it assumed an irregular oval form about 2 in. in length by about $\frac{3}{4}$ in. in width, entirely surrounding the bottom of the plate. In the course of about half an hour the spongy metal which formed beyond the black mass referred to acquired a grey colour, and bright fibrous flakes of the metal, as before noticed, rose from the spongy deposit and floated on the surface of the liquid. The experiment was continued for some time longer, in the hope that crystals of the metal would grow out from the spongy metal, as I had found them do when electrolyzing tin solutions under similar conditions. In this, however, I was disappointed, but when examining the spongy metal some time after, noticed that portions of the grey deposit nearest to the bottom of the vessel were hard and granular to the touch, while the black metal was perfectly impalpable. From this I was led to conclude that a process of aggregation had commenced, which would probably, in the course of time, result in the formation of crystalline metal. This I will endeavour to determine at a future time, but may say, however, that I have succeeded in obtaining fibrous crystals of bismuth in another way, to which I shall shortly have the pleasure of directing attention. It should be stated that the spongy deposit obtained in this experiment, being rendered buoyant by the hydrogen, had a great disposition to break away from the cathode and rise to the surface of the liquor.

12. *Basic Nitrate of Bismuth, Aqueous Solution of.*—When a solution of nitrate of bismuth (terintra) is poured into water, a copious white precipitate of basic nitrate is formed (pearl white), and in order to get rid of the nitric acid solution surrounding the white deposit repeated washings with water

are necessary. After one or two washings, however, a considerable proportion of the basic nitrate becomes dissolved in the water. This being the case, it was determined to see how far such a solution would serve as an electrolyte, for which purpose the final washing water from the basic salt was carefully decanted after the white deposit had well subsided, and the liquid electrolysed with the current from three Daniells in series, a brass plate, as before, being used as the cathode. Immediately after the plate was immersed in the liquid referred to it became coated with bismuth of the usual reddish colour, but the film quickly assumed the dull-black appearance so commonly observed in bismuth deposits. The current being too strong, a single cell was next tried, when a film of bismuth at once formed on a newly-prepared plate, but, as before, this was quickly followed by the black spongy metal.

13. *Carbonate of Bismuth in Bitartrate of Potassa.*—To prepare a solution of this composition, a boiling solution of bitartrate of potassa was first made, and to this was added moist carbonate of bismuth, the mixture being well stirred and boiled for a few minutes; it was then set aside to cool, and settle, and the clear liquid then decanted for use. The current from two Daniells in series was used, and a brass plate then immersed, which soon became coated with a good reguline deposit of bismuth. The metal did not, however, adhere very firmly to the plate. A second plate was next put into the bath and allowed to remain undisturbed for a short time, when it was found that the bright film at first deposited became coated with a blackish film, which was easily removed by rubbing with the finger. The metal, in fact, ceased to deposit in a reguline form after a thin film had formed on the plate.

(To be continued.)

MINING COAL BY THE USE OF ELECTRICITY.

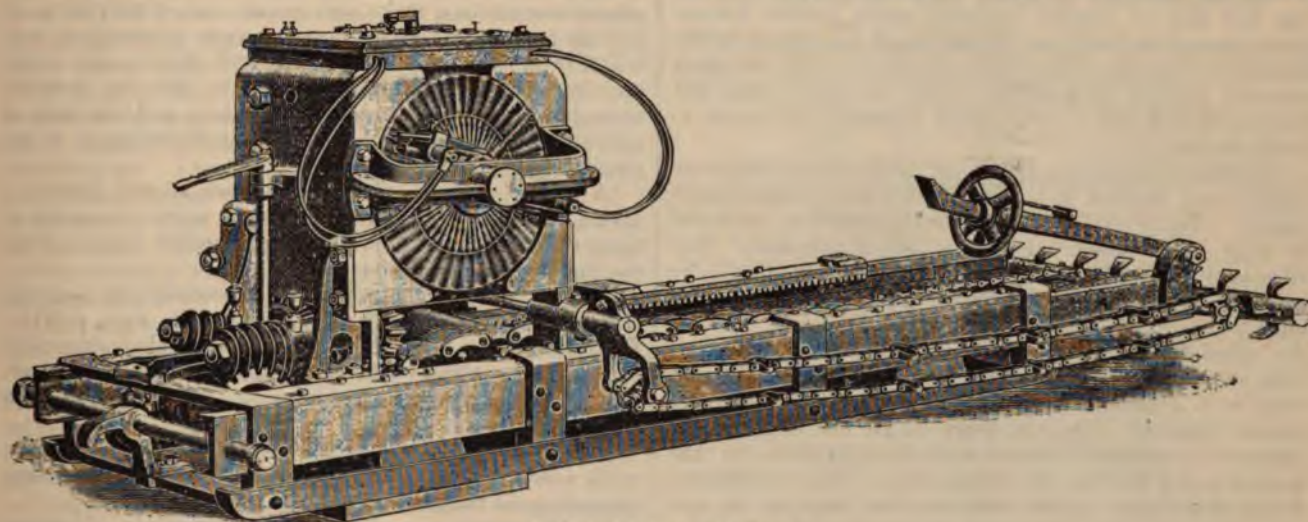
There are so many reasons why electricity is a superior agent for conveying power into a coal mine, there to be

dust the first day is in use, so that its beautiful red coils will know it no more.

The Jeffrey Manufacturing Company, of Columbus, O., has been for a number of years manufacturing the Legg coal mining machine, which heretofore has been operated by compressed air. The company has been untiring in its efforts for the past two years to substitute electricity, and has been assisted by several of the most able electrical and mechanical experts in this country. Several of the larger motor companies have made efforts in this direction. A great deal of money was expended in experiments. Finally, the company secured the valuable services of Foree Bain, of Chicago. Mr. Bain went into the mines, and for a time became a practical miner in order to study the conditions to be met and the difficulties to be overcome.

The illustration shows the electrical mining machine, as perfected by Mr. Bain. The motor occupies a space about 20 in. square; it is very solidly and substantially built. The characteristics of the details do not show in the engraving. At present the inventor is not ready to describe them. The motor requires 220 volts and a current of 60 amperes when working at its maximum capacity, and develops 15 mechanical h.p.

The machine has been in practical operation every day at the mines of the Shawnee and Iron Point Coal Company, Shawnee, O., since the 1st of May. It only requires three and one-quarter minutes to make a cut of five and one-half feet deep and three feet face. The cuts are made and the cutter-bar is withdrawn within four minutes, and the machine is moved ready for another cut in less than 10 minutes. It requires no effort on the part of the attendant while the machine is at work. At this rate, six cuts per hour, or 60 cuts per day of 10 hours, can be easily made, and the machine will undercut 200 tons of coal. This is the capacity of the first machine which is now in operation. It is the opinion of those able to judge, that, under favourable conditions, 300 tons of coal can be undercut per day. Mr. Bain has also installed in this mine an electric hauling plant of his construction. The gathering motor is only 8 h.p., and hauls from six to



Electrical Mining Machine.

used in the operations incident to mining coal, that most of the larger mine operators have been looking forward to the time when electric apparatus could be constructed that would withstand the rough usage to which it must necessarily be subjected.

The fact that power can be transmitted by this means is not sufficient. The apparatus must be practical in the extreme sense of the word, for there is no other place on the face of the earth, or under it for that matter, where an electric motor receives such hard treatment, and where so much is demanded of it. It must remain unaffected by condensation, caused by draughts and changes of temperature; water, which constantly drips from the roof of most mines, must not injure it; it must be expected tons of falling slate and chunks of coal will fall in and upon it without producing harm; it will be covered with mud and coal

seven loaded cars of 2½ tons. The mining machine takes current from the same circuit, as do also quite a number of incandescent lamps. Mr. Bain is now constructing three additional mining machine motors and a 20 h.p. locomotive for the Jeffrey Manufacturing Company, to be used in this mine.—*Western Electrician*.

PROBLEMS IN ELECTRIC TRACTION.*

BY DR. LOUIS BELL, PURDUE UNIVERSITY.

(Continued from page 9.)

Aside from the general conditions to be met, an electric road encounters certain difficulties quite peculiar to itself, some of them real, others rather to be classed as imaginary.

* From the *Electrical World* (New York).

In the first place, there is a widespread popular delusion that the overhead wire in general use is exceedingly deadly, and that the track used as return circuit is scarcely less so. As a matter of fact, the maximum potential used in tramway work, 400-500 volts, cannot be classed as even dangerous. It would, of course, be decidedly unpleasant to receive the full effect, but there is no reason to believe that it would imperil life, or cause a more serious injury than burns at the point of contact. In fact, a large number of employes of electric roads have received the full E.M.F. without injury. In addition, the wire is carried so far out of reach that the public cannot get at it, and even if it falls it is soon gotten out of the way. The track return is perfectly harmless. These facts are well known wherever an electric road has been in operation for any length of time, but the use of very high potentials for arc lighting has given the electric current a popular notoriety that it does not deserve.

It is, nevertheless, quite clear that the overhead system must be abandoned in large cities, except in some few special cases. Eventually, all wires must and will go underground in such situations, and electric tramways, like electric lighting systems, must face the difficulty. That this difficulty is a real one, no one who has watched the progress of underground work will care to deny, but the ostentatious collapse of certain electricians under the weight of the problem is hardly in keeping with the skill and readiness they have heretofore displayed.

Fortunately, the case for tramways can be easily solved either by a conduit or storage batteries. Which of the two will furnish the ultimate solution of the problem depends mainly on the progress made in accumulators within the next few years. Could the accumulator be reduced to a reasonable weight, it would certainly furnish the ideal method of electric traction.

There is one question, however, that is of great and growing seriousness in electric traction, and that is the interference of an electric tramway of the ordinary type with the telephone lines in the vicinity. First, there is the danger of a cross circuit between their respective wires where the damage will be all on one side; and second, the fact that an electric tramway using ground connections may quite paralyse all the telephone circuits in the immediate vicinity. The first danger may be in great measure avoided by a proper system of guard wires, but the second difficulty is of no small moment, and cannot so easily be met.

The effect of a traction line on all neighbouring telephone lines is very marked, in some cases rendering them almost useless. The exact nature of the phenomena produced is very complicated. Listening at a telephone thus affected, it is possible to follow in considerable detail the operation of the motors. Whenever a car is started a low hum is heard, gradually rising in intensity and pitch as the speed increases, and as the connections are shifted from step to step on the switchbox. Beneath this distinct note is a confused whirring sound of lower pitch and greater intensity. The effects are clearly due to the superposition of several different periodic variations in the current and E.M.F. on the traction line. The transference of this disturbance to the telephone line depends on two quite distinct causes: first, the direct effect of induction; and second, the disturbance due to the fact that both systems are grounded at points not very far distant from each other. The relative importance of these two causes varies very widely in different places. Here most of the trouble comes from direct induction, while it is not uncommon to find nearly all of it coming from the grounds. Both causes must in general be eliminated to avoid the difficulty.

Examine first the cause of the fluctuations which produce induction. Any motor the armature of which is wound in a finite number of sections must, in the first place, produce sinusoidal variations in the motor E.M.F. These, however, are of small amplitude, less than one-half per cent. in motors generally used, and are in this case of minor importance. Their period corresponds to Nn per second, where N is the number of revolutions per second and n the number of segments in the commutator.

Besides this there is a periodic variation of the ohmic

resistance of a motor due to the fact that the brush in sliding from segment to segment momentarily short-circuits the ends of an armature-coil.

Let n be the number of armature sections, and r the resistance of each, R_1 the resistance of the armature from brush to brush, and R_2 the resistance of the series field coils. Let the motor be supplied, as is usual, in practice at a constant E.M.F. Then, assuming the brushes to be 180deg. apart, and touching one segment the resistance of the motor is:

$$R = \frac{n r}{4} + R_2.$$

Now, revolve the armature until each brush touches two segments, and—

$$R = \frac{(n-2)r}{4} + R_2.$$

Therefore, when the motor is running at a constant speed the current will be subject to fluctuations of amplitude determined by the above, and occurring nN times per second.

Take, for example, the ordinary Sprague motor where $n=24$, $R_1=1.2$, $R_2=3.3$ (last step) $r=.2$ the amplitude of the fluctuation is somewhat over two per cent. of the normal current.

As the cars are fitted with two motors in parallel, if the two sets of brushes short-circuit simultaneously we should have a double effect and a variation of two per cent. in the total current through the car. If they do not short circuit simultaneously, a variation of half the amount $2nN$ times per second.

Another small periodic disturbance is due to the fact that the brushes are very generally unsymmetrically placed, with the result that the motor E.M.F. in the halves of the armature will be slightly unequal. The result is as if a weak alternating current were acting in the armature with $2Nn$ alternations per second.

Another and more serious difficulty occurs when the insulation between the commutator segments is somewhere near the width of the contact edge of the brush. In this case there would be produced a fluctuation which might almost amount to a make and break, and would have N periods per second if the brushes were symmetrical, and $2N$ if they were not. The fluctuations due to this cause are frequently considerable. Add to this the possible irregularities in the commutator contact, and we have a combination of sinuous and alternating disturbances of an immensely complicated kind.

Of course, the remedy for induction is well known—giving the offending current a return wire, so placed as to neutralise its effect, or adopting a similar process with the line disturbed.

The case of earth disturbances has recently been investigated by Mr. Preece (*The Electrician*, vol. xxii., p. 618). His results show that the effect of a grounded sinusoidal current may extend to a great distance and may cause very much worse disturbance on a telephone line than simple induction.

These facts would suggest that in all electric traction work a complete metallic circuit should be used, and that grounding *via* the rails should be avoided.

Double contact wires, however, are certainly objectionable where they have to be supported by a system of wires, both as being somewhat troublesome mechanically and as being unsightly. Unless guarded with great care, they will much increase the danger of troublesome short circuits. Where, however, they can be supported on brackets, and hence more efficiently guarded, their use should furnish an effective way out of the telephone difficulty.

But in very many cases it is desirable to use the single overhead wire, and some simple means of avoiding at once earth and induction is desirable. Clearly it is not sufficient to use the track alone for a return or the track with an auxiliary wire beside it, as is quite usual.

For the current of supply is, or always should be, divided between the trolley wire and a line wire connected with it at intervals, hence the inductive effect of this overhead system can never be balanced by an equal current along the ground by reason of unequal distance from the overhead telephone wires.

I would, therefore, suggest the following as perhaps the simplest and easiest way of abolishing the induction. Connect the rails so as to form a return circuit leading either back to dynamo or to a main earth at some unobjectionable point. Then remove the auxiliary wire from the track to form a second return circuit parallel to the line, and nearer than it to the telephone lines. Finally connect these two return systems at any convenient number of points by wires under the surface and up the nearest pole. Neither track nor these cross wires need be carefully insulated

The supply current, then, is divided between line and trolley wire and the return between auxiliary line and track. The most of the former current would pass along the line wire, and most of the latter along the track. Since the coefficients of self-induction will be quite nearly equal, the disturbing fluctuations will divide in the same ratio as the currents, and we have a system of four conductors in which the two fixed ones, trolley wire and track, nearly neutralise each other, the larger current being the more distant from any overhead wires; while the two movable factors, the two-line wires, can be so arranged as to complete the compensation. Given the resistances, such a system can be easily arranged, so that the resultant induction on any single wire would be *nil*, and remain very small throughout any compact system of wires. It would be practically very difficult to secure compensation with fewer conductors than four so long as two of them must be approximately fixed. This four-conductor system could be applied to existing lines with small trouble and expense.

I will now pass to the efficiency tests made on the electric road in this city.

The La Fayette-street Railway Company operates 3-6 miles of single track on the Sprague system. The line was operated by horses until the summer of 1888, and has now been operated as an electric road about eight months. The track is a branching one, extending on both sides of the Wabash river, and reaching well out to the city limits. The grades are in some places severe. In the central part of the city which lies in the whole river bottoms the grade is very light, but on the east side the road rises sharply, taking at first a slight grade, and then one of about 6-6 per cent., and fully 800ft. long, averaging 7-34 per cent. for 100ft. in one section. On the west bank of the Wabash the road rises over the bluff, taking a 6 per cent. grade for about another 800ft., with a very sharp curve near the middle point. There are more than a dozen curves in the road, most of them of a rather short radius.

There are seven motor cars, of which six are in continuous use. The cars are closed, weigh complete about 5,200lb., seating 20 persons readily, and holding at a pinch between 40 and 50.

The plant combines a plant for stationary motors with that for the street cars. There are two of the regular Edison railroad dynamos coupled in parallel, each having a normal capacity of about 30,000 watts at 500 volts, or rather more in case of need. Two other Edison dynamos of about half the capacity supply the power circuit at a potential of about 250 volts.

Power is supplied by a Hamilton-Corliss engine, 14in. by 36in., running at 88 revolutions per minute. Two large horizontal tubular boilers furnish steam at a normal pressure of 85 pounds, and have a large margin of capacity. The two railroad dynamos and one of the power dynamos are used continuously, the former 16 hours, the latter 10 or 12 hours per day. The first car leaves the end of the road at 6.20 a. m., and the last car gets in at 10.20 p. m. Each car makes from 35 to 40 miles per day, is operated by a single man, and can, if necessary, take one of the spare cars in tow to accommodate an unusual crowd.

The first tests were made at the power station, with the object of determining the actual electrical output on the road, the indicated horse-power necessary to produce it, and the amount of coal required. To this end the engine was indicated every five minutes throughout the day, beginning and ending this series with a group of friction cards. Meanwhile the electrical output was simultaneously obtained from volt and ampere readings. The volts were read on an Ayrton and Perry voltmeter, and the amperes

on the station ammeter, which was afterwards checked as well as practicable by a new Ayrton and Perry ammeter. The coal burned during the test was measured and its weight determined.

The results of the friction cards were as follows: Friction of engine + 3 dynamos average—morning 12.5 i.h.p., night 19.1 i.h.p.

A number of cards taken on different days gave almost exactly 16 i.h.p., which we may take as a fair average for the power wasted in friction. The dynamos are all belted to a main shaft which is driven by a belt from the engine. This shaft is well in line and kept in good order. In fact, the station is a model of neatness and the machinery is looked after with unusual care.

These figures give for the approximate friction of the engine alone 12-14 i.h.p. In other words, we may take the engine friction as 10 per cent. of its rated full power.

The five-minute indicator cards were worked up very carefully, and gave as the average continuous power throughout the day 39.05 i.h.p. The highest figure reached was 79.3 i.h.p., and from this figure the power fell to the friction cards as a minimum.

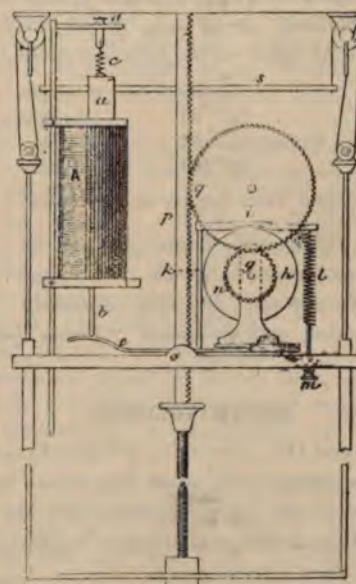
In a similar way the readings of volts and amperes were combined, and showed an average that was remarkably low, being 10,881 watts, equal 14.58 e.h.p. The greatest output recorded was 90 A., 410 V., 36,900 watts, equal 49.46 e.h.p. This figure was reached only for a few seconds. This is not as great an output as is sometimes observed on the line, where occasionally 75 e.h.p. may be demanded, though such a call for power is quite unnecessary under ordinary working conditions. The ammeter readings not infrequently fell to zero for a few seconds at a time.

To obtain the total e.h.p. for comparison with the i.h.p., we must add to the above the amount obtained by a similar approximate integration of the power used on the stationary motor line, which was 1.25 e.h.p.

(To be continued.)

ARC LAMP OF MM. PERRIN AND MASSON.

The accompanying illustration of this lamp almost explains itself. The mechanism consists of a train of



clockwork, and a brake. The brake is actuated by the core of the electromagnet, *A*, which carries a rod, *b*, to press on the lever, *e, f*, whose fulcrum is at *o*. The stand-piece, *g*, carries the wheel shaft. It will be seen the wheel *n* gears into *q*, which again gears into the rack, *p*, which carries the upper carbon. The brake, *i*, is connected to the lever, *e, f*, and the spring *l*, which is regulated by the screw, *m*. It will easily be seen how the current through *A* pulling more or less upon the core, *a*, brings about the greater or less braking of the wheel *h*. The core is supported by the spring *c*, regulated by *a*. The lamp is claimed as simple and effective, but one hardly sees where the advantages come in.

THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence ; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices :

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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"OUT FOR AN AIRING."

The old race of astrologers pretended to read the past, present, and future by means of the stars ; the present race of prophets, wiser in their generation, lay claim to no such powers, but contend that similar causes lead to similar results. No doubt this is true, but then we never can be sure that the causes which regulate trade are precisely similar, hence, though we are tolerably sure of what has resulted, we should hesitate to tell future results. There is a decided similarity about the proceedings of certain companies now and the proceedings in 1882—yet with differences—so whether the action will lead to good or bad results who can tell? Readers of "Ivanhoe" will remember that Robin Hood's followers were sent out in various directions to watch various roads, and if opportunity occurred to relieve travellers thereon of superfluous wealth. Usually a certain percentage of the divisions would meet with more or less success, while the remainder returned empty-handed. So no doubt is the hope of the managers of the various companies that have been notifying local authorities of their intention to proceed to get provisional orders. The senders of the notices can have no expectation of being successful in each case ; in fact, many of them, like the horses referred to in a recent trial, are "out for an airing," while others are "on the job."

We shall put forward several objections to this system, and also to one of the phases which naturally arises from it. In the first place, the system leads to an indiscriminate scramble. Half-a-dozen notices are sent to Edinburgh. Now are these notices in competition? Are the local authorities to choose which one they will support, and which they will oppose? Has anyone of the applicants any standing in the place, or are all fishers in troubled waters? What bait will they gild their hooks with, for it seems only too plain, taking men as we find them, that in many instances—of course we do not now refer to Edinburgh—the applicant that meets with most support will be the one whose bait is best taken. Some folks term it bribery and corruption, but that is not a euphonious term. Far be it from us to withhold support from anyone attempting legitimate business. We have yet to learn that this is an attempt to get legitimate business. Is not the position of these applicants, for the most part—note we distinctly limit our criticism—that of promoters, whose object, if they are supported, and get the provisional order, is to get up a local company, to which they will for a consideration transfer their interests? The matter might be better managed if the local people themselves were sufficiently interested in, and sufficiently desirous of seeing the work carried out, to take the initiatory steps themselves. In some cases, no doubt, there is a strong local support, and the applicants have been

requested by their local supporters to give this notice. The local people do not feel strong enough without external aid to carry the work through, and in these cases the application is legitimate. If, however, three or four cliques are found supporting three or four applicants, real work, instead of being facilitated, will be retarded. Electric light and power distribution does not lend itself to competition; like gas distribution, it is bound to be of the nature of a monopoly. To get the monopoly the competitors will spend money freely, and no end of troubles and litigation will result. When there is more than one applicant for a provisional order in the same place, the rivals had better meet and draw lots as to who should be left alone rather than proceed to cut each other's throats. To be successful out of six, means increasing the necessary preliminary expenditure, more than five-sixths of which is absolutely wasted, for success is obtained at a greater cost than if there was no rivalry. There is room and work for the whole half-dozen and more, so that viewed calmly there is no need for excessive competition. The great danger is that between so many stools the local authorities sit quietly upon the ground, and instead of aiding the industry give it the cold shoulder.

Let us suppose that a local company is formed, and communicates with one of the large manufacturing firms or supply companies. It is a common case to find the local company asking the manufacturer to take part payment in shares, and just as common to find this done. For the sake of simplicity, take the manufacturer's profit at 20 per cent.; he divides this, is satisfied with 10 per cent. in cash and 10 per cent. in shares. If the concern succeeds, the shares should ultimately prove of more value than the cash; if it fails, then his profits are only 10 per cent. We cannot see that there is any objection to this method of doing business. Another case is when a large number of companies are promoted from one centre which has nothing to do with the localities wherein companies are to be promoted, the signatures to the memorandum of association being principally those of clerks, or men who have no stake at all in the company. Yet these men are able to appoint the first directors, and so put the management of the companies into hands really not the most suitable for the purpose. The law is certainly complied with, but a worse law it would be impossible to devise. A company is practically handed over to those who have no care for the ordinary shareholders, to those who possibly have not contributed one sixpence to the capital of the company, who are promoters and paid as promoters, and whose sole object is to play into the hands of self and partners. It should be impossible for any company to be so saddled with directors, but so it is, and being so, attention must be called to it, and every effort made to avoid its further introduction into

electric lighting operations. The aim of every individual member of the industry at the present time should be to make each separate installation, be it small or large, a success. There need be no failures. We know enough to ensure steady and good lighting, though the cost of doing the work may be rather more than certain sanguine estimators would have us suppose. If we play into the hands of professional company-mongers, we play into the hands of those who have no real incentive to make each installation successful. They have gathered these grapes before the real work of an installation is reached, and it suffices for them that a few installations prove successful. These will always be put forward to ensnare the public, and the Englishman is sufficiently a gambler to risk more or less coin in speculation. We would, then, have these two things remembered. There is no need for excessive competition, and in the formation of companies, the men at the head of affairs should be those whose interests are for permanent successes, rather than the immediate floating the company in the market.

CORRESPONDENCE.

NEW AUTOMATIC LAMP.

TO THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—In your issue of July 5, I notice that you give a description of a new automatic lighting lamp for use in railway carriages, etc., and mention it as being one of the latest applications of the coin-freed principle.

This idea is scarcely new, as I have been experimenting with apparatus of this description for the last two years, and have made several forms of automatic lamps with clockwork timing arrangements. I have made no secret of the fact, and a large number of my friends have seen the machinery I have made at different times and suggested various improvements.

After many experiments, however, I came to the conclusion that clockwork was not the best arrangement to use, on account of its liability to get out of order through the jolting during travelling and the probable rough usage to which the apparatus might be subjected by unskilful hands, such as railway porters and others. Also when batteries were used in close contiguity to the clockwork apparatus everyone knows what would happen.

I therefore turned my attention in another direction, and my provisional patent of March 29th, 1889, No. 4,530, was the result. In this arrangement I used no clockwork, and the controlling arrangements are the simplest imaginable.

The penny is dropped into the apparatus, a handle half turned, and the light immediately shines forth, and without any arrangement of clockwork trains, springs, etc., the time is controlled and the light goes out at the end of half an hour.

An advantage I can claim, which perhaps could not be so easily managed by clockwork arrangement, is that I can arrange my apparatus to burn any time from two minutes to, say, ten hours by one half-turn of the handle.

I should have published a description of my invention earlier, but I considered the clockwork arrangement too unreliable for general use, and therefore withheld the description until I should have the lamps working on my latest principle.

I may add that there has been a working model of my automatic lighting lamp at Messrs. Wheatley Kirk, Price, and Goulty's offices since the filing of my provisional patent

in March, and, although it is somewhat roughly made, it works admirably.

In place of that portion of the apparatus which is to do the "chucking out" part of the business in the automatic lamp you described, I prefer to add an arrangement to my apparatus which prevents money being put in when the battery is exhausted, as it is quite possible that when one part of the machine is stopped the other part might also refuse to work; and where would the money be then?—Yours, etc.,

H. J. DOWSING.

London, E.C., July 10, 1889.

BRADFORD.

The Board of Trade has made the following rules for the better ensuring safety in the supply of electricity by the mayor, aldermen, and burgesses of the said borough, hereafter called the Corporation, pursuant to the provisions of the Electric Lighting Act, 1882, and the Act of 46 and 47 Vic., cap. 220, confirming the Bradford Provisional Order for such supply of electricity; that is to say:

1. *Rules for Wiring of Houses.*—All wiring, fittings, apparatus, and other appliances must be supplied and fixed in accordance with the "Rules and Regulations of the Society of Telegraph Engineers and Electricians" (April, 1888), and of any other regulations which the Corporation may require.

2. *Conductors.*—The sectional area of all conductors shall be so proportioned that the maximum current conveyed in any conductor shall not exceed the ratio of 1,000 amperes per square inch of section of copper conductor.

No portion of the metal work of any brackets, electroliers, or other electrical fittings, or of any gas or water pipe, is to be used as part of the electrical metallic circuit, as "earths" might readily be formed by any such connections.

3. *Insulation Resistance of Installation.*—The insulation resistance of the entire installation (when all the mains, wires, fittings, lamps, motors, and other appliances are fixed) shall not, as proved to the satisfaction of the Corporation, be less than the total number of ohms which shall be indicated by the number resulting from the division of 10,000,000 by the number expressing the maximum electric current in amperes which has been named by the consumer in his application for his supply of electricity.

In the event of the insulation at any time falling below the above standard, and continuing so, the Corporation may, after due notice, discontinue the supply of electricity to the premises.

4. *Unauthorised Extensions, Penalty attached to.*—Should it be found that any consumer is using a current in excess of the maximum with which he has required the undertakers to supply him, without notice having been given in accordance with the Act, the Corporation may, if they think fit, discontinue the electric supply to this consumer until they have made proper provision for such increase.

5. *"Earths."*—All connections direct with "earth," or connections tending to cause "earth," such as with gas or water pipes or other metallic bodies, are absolutely forbidden, without the express sanction in writing of the Corporation.

6. *Penalty attached thereto.*—Should any such "earths" be at any time found to exist in an installation, whether through an intentionally made connection or by neglect of any of the prescribed regulations as to wiring or as to fittings, or from any other cause, the Corporation, if they deem it necessary or advisable, may discontinue, even without notice, the supply of electricity to the installation until such "earths" or other defect has been made good by the consumer to the entire satisfaction of the Corporation, and so notified in writing.

7. *Dead Ends, etc., to be Sealed up.*—All dead ends which may occur in the installation should have their extremities carefully sealed up, so as to avoid all chance of "earths" being formed therefrom.

8. *Notice as to Leaks.*—Should any leak, or "earth," or other serious defect be discovered by the consumer, either within the installation itself, or in its immediate vicinity outside the premises, he is bound at once and without delay to give notice thereof to the Corporation or their electrical engineer, so that the defect may be at once properly remedied.

9. *Main Disconnecting Switches.*—Two switches, one on each main respectively, shall be fixed in a readily accessible position, on the two mains leading from the meter to the premises, at a point immediately adjacent to the meter if possible, and subject to the approval of the Corporation or their electrical engineer. These switches must be so arranged that the entire of the current passing into the installation can be, when necessary, cut off by them.

10. *Access to Main Switches by Corporation Officials.*—The proper officers of the Corporation shall have the right of access at all times to these switches.

11. *Alterations, Repairs, etc., Notice of.*—In the event of any alterations, repairs, extensions, or other interference, from whatever cause, with the ordinary working of the installation, notice must be given to the Corporation or their electrical engineer at least 24 hours before such alterations or other operations commence, and indicating the time at which it is intended to commence such operations.

12. *Current to be Cut Off during Alterations, Repairs, etc.*—During the entire time, whether continuously or with interruptions, that such alterations or other operations are in course of execution, the electric supply from the outside must be entirely disconnected from the premises by means of both of the above-named main disconnecting switches. Any exception to this regulation must have the express sanction in writing of the Corporation or their electrical engineer.

13. *Interruptions by Corporation during Alterations, Repairs, etc.*—In the event of the electric supply not being properly and efficiently cut off from the premises whilst such alterations, repairs, or other operations are being carried on, the officers of the Corporation may, if they deem it necessary, even without notice, completely interrupt the electric supply to the premises, in any way which they think advisable.

14. *Disturbance of Streets, etc., in Vicinity of Electrical Cables, etc.*—Whenever any disturbance or other interference may be required or contemplated with the surface or other parts of any street, causeway, pavement, or any other place in the vicinity of any electrical cables, wires, or other apparatus or matter connected with the public supply of electricity, the person or body charged with carrying out the above-named disturbance or interference of such street, or other places, shall give notice in writing of such intention to the Corporation.

15. Such notice should, where possible, be delivered at least twenty-four hours before the commencement of such intended disturbance or other interference.

16. *Notice to the Electrical Engineer's Office.*—The notice should also designate the locality of such intended disturbance, etc., as also the time at which such operations are proposed to be commenced, so as to allow of the attendance at such locality of an official from the electrical engineer, in order to point out the exact position of the electrical cables, wires, and other apparatus, and also that he may take any steps required for the proper protection thereof.

17. *Penalty.*—Any person offending against or not complying with any of the above regulations shall be liable to a penalty not exceeding £5, and a daily recurring penalty not exceeding such sum so long as the offence or neglect may continue.

18. *Electrical Engineer.*—In the above by-laws, the term electrical engineer shall mean the person whom the Corporation may, from time to time, appoint to take charge of their electrical works.

19. *Office.*—The Corporation shall appoint an office in the Town Hall where all notices may be served in connection with the above by-laws.

LONDON CHAMBER OF COMMERCE.—ELECTRICAL TRADE SECTION.

FOREIGN IMPORT DUTIES ON DYNAMO-ELECTRIC MACHINERY AND ELECTRIC LAMPS.

The following statement has been prepared by the Board of Trade, and is published by the London Chamber of Commerce in view of the increasing importance of the trade in electric apparatus and appliances:

Countries, and Tariff Classification.	Rates of Duty.	English Equivalents.	Countries, and Tariff Classification.	Rates of Duty.	English Equivalents.
RUSSIA—			FRANCE—Machines(continued)		
Dynamo-electric machines :	Rbbs. Cop.	£ s. d.	75 per cent. and above of	Frs. Cts.	£ s. d.
If the preponderating material is of copper	Pound 3.50	Cwt. 1 14 6	cast iron	100 kilos. 6.00	Cwt. 0 2 5½
Ditto of iron or steel.....	" 1.40	" 0 13 10	Electric lamps :		
Electric lamps	Information not yet received.		Incandescent lamps of blown glass	" 18.50	" 0 7 6½
SWEDEN—			Accessories of electric lighting made of copper, comprising commutators, regulators, lamps, etc.....	" 20.00	" 0 8 2
Dynamo-electric machinery...	*Free.	*Free.	[Note.—Accumulators pay duty according to the metal of which composed.]		
Electric lamps	According to material of which chiefly made.		PORTUGAL—		
[*Note.—This information is given by the Swedish authorities under reserve, as they are unable to give an absolute decision.]			Dynamo-electric machinery imported entire	Kilog. 15	Cwt. 0 3 5½
NORWAY—			Ditto, imported in separate pieces	" 25	" 0 5 8½
Dynamo-electric machinery...	*Free.	*Free.	Electric lamps; these are chargeable according to material of which made :		
Electric lamps	*According to material of which chiefly made.		If of glass	" 110	" 1 5 2
DENMARK—			" iron	" 200	" 2 5 9
Dynamo-electric machines ...	Pund 0.02½	Cwt. 0 2 4½	" bronze	" 230	" 2 12 7
Electric lamps	*or 10 % ad. val. According to material of which composed.	*or 10 % ad. val.	SPAIN—		
GERMANY—			Dynamo-electric machines ..	Pes. Cts. 100 kilos. 8.00	" 0 3 3
Dynamo-electric machines (so far as they cannot be described as "Locomotiven" or "Lokomobilen")	Mks. Pf.		Electric lamps; chargeable as ordinary lamps according to material of which composed, as follows :		
Preponderating material being of cast iron	100 kilos. 3.00	Cwt. 0 1 6½	Of copper.....	" 86.68	" 1 15 3
Ditto of wrought iron	" 5.00	" 0 2 6½	" iron (according to quality).....	" { 6.10 to 19.84 }	{ 0 2 5½ to 0 8 0½ }
Ditto of other common metal	" 8.00	" 0 4 0½	" tin	Kilog. 3.00	" 6 1 11
Electric lamps:			" zinc	100 kilos. { 23.75 to 45.00 }	{ 0 9 7½ to 0 18 4 }
Incandescent (Glüh) lamps of glass in conjunction with other materials, so far as the same cannot be classed as hardwares, etc., with the exception of cases in which platinum wire is used	" 30.00	" 0 15 3	" other common metals ..	" { 45.00 to 34.65 }	{ 0 18 4 to 0 14 1 }
Electric arc (Bogen) lamps and other electric lamps ..	According to the material of which made.		" earthenware	" 26.58	" 0 10 10
HOLLAND—			" porcelain	" 37.50	" 0 15 3
Dynamo-electric machinery...	Free.	Free.	ITALY—		
Electric lamps and appliances for electric lighting, not forming part of the machinery	5 % ad val.	5 % ad val.	Dynamo-electric machines :	Lire Cts.	
BELGIUM—			Up to 20 h.p.	100 kilos. 25.00	" 0 10 2
Dynamo-electric machinery :			Of 20 h.p. and above	" 16.00	" 0 6 6
The duties are assimilated to those on machines and machinery of all kinds, which are—			Electric lamps of bronze, brass, steel, or iron	" 30.00	" 0 12 2
Machinery of cast iron.....	100 kilos. 2.00	Cwt. 0 0 9½	Ditto, of other materials	According to material of which made	
Ditto of wrought iron or steel	" 4.00	" 0 1 7½	AUSTRIA—		
Ditto of wood.....	10 % ad val.	10 % ad val.	Dynamo-electric machines ...	Fls. Kr. 100 kilos. 5.00	Cwt. 0 5 1
Ditto of copper or other metal	100 kilos. 12.00	Cwt. 0 4 10½	Electric lamps	Information not yet received.	
Electric lamps	10 % ad val.	10 % ad val.	SWITZERLAND—		
FRANCE—			Dynamo-electric machines ...	Frs. Cts. 100 kilos. 4.00	Cwt. 0 1 7½
Dynamo-electric machines :			Electric lamps	" 16.00	" 0 6 6
Weighing less than 30 kilos.	Free.	Free.	GREECE—		
Weighing 30 kilos. and above and containing—			Dynamo-electric machines ...	Free.	Free.
Less than 50 per cent. of cast iron	100 kilos. 15.00	Cwt. 0 6 1	Electric lamps :	Drs. Lep.	
From 50 to 75 per cent. of cast iron	" 10.00	" 0 4 0½	If of glass or plain porcelain	Oke 1.00	Cwt. 1 12 0
			If inlaid, coloured, or gilt..	" 2.00	" 3 4 0
			All others	According to material of which made	
			ROUMANIA—		
			Dynamo-electric machines ...	Free.	Free.
			Electric lamps	+ Cannot be stated.	
			TURKEY—		
				8 % ad val.	8 % ad val.
			UNITED STATES—		
			Dynamo-electric machines ...	45 % ad val.	45 % ad val.
			Electric lamps	45 % ad val.	45 % ad val.

* At the option of the importer. + The Roumanian authorities are unable to give a decision as to the duty without having a sample submitted to them.

LEEDS.

A long report of the Electric Lighting Committee was considered by the Town Council of Leeds last week. This report contained certain suggestions, some of which were referred back for further consideration, others were accepted. The report commences with a detailed history of the various lighting experiments carried out at Leeds, after which comes the suggestions about lighting the central portion of the town. The following is the scheme as at present under consideration, as given in the report:

"Proceeding with the scheme for lighting the central portion of the town, your committee sought information from the tenants of shops bounded by Albion-street, Boar-lane, Briggate, and Commercial-street, to ascertain the disposition of the tradespeople in the town in regard to an electric light supply. The result of this enquiry was, that the desire to have the electric light was almost unanimous. Finding the desire for the light so general, your committee then mapped out a district, and determined to ascertain, for the information of the Council, details as to the work and cost involved in lighting the same. This district is shown by a pink colour on the plan annexed to this report, and is bounded by Vicar-lane, New Market-street, Duncan-street, Briggate, down to the bridge, Boar-lane to the new station, Park-row, Guildford-street, Upperhead-row, New Briggate, and North-street to Vicar-lane. After ascertaining the exact number of lamps which would be required in a given area, and then using this as a basis, it was found that the number of public and private lamps required for the district proposed to be lighted would be about 37,500.

"In regard to street lighting, your committee reports that whilst incandescent lamps have proved a complete failure, should the Council at any time think fit to light the streets of this district with arc lamps, the system here dealt with readily permits of the same, as the power required is only equal to 4,000 incandescent lamps, which number is included in the total 37,500. From this fact, too, the Council will understand that this system permits customers to use either arc lights or incandescent lamps, or a combination of both. As in practice it is found that only two-thirds of the number of lamps in an electrical installation will be burning at one time, engines and dynamos for the installation proposed need only be sufficient for 25,000 lamps. The horse-power required for this number of incandescent lamps would be about 1,700 ind. The lamps in this scheme are taken nominally at 10 c.p., but they will no doubt be burned somewhat higher than that. This candle-power has been taken because in London it is found equivalent in power to the gasburner generally used.

"As to the leads, or wires, the question of overhead v. underground wires has been very much discussed, more especially, perhaps, in America, with the result that the system of underground wires in iron pipes is adopted as the best. The considerations which led to this conclusion were the reduced risk of personal danger; the greater ease of making connections or repairs; and the removal of the unsightly appearance which the large electric wires and their supports presented. This matter, however, is now regulated by the Board of Trade; and of such importance does the Board at present deem this mode of laying, that it makes it a condition in its orders. Further, in the report just made by Major Marindin on the applications for provisional orders and licenses for lighting many of the districts of London, he recommends 'That wherever the company now supplying a district by means of overhead wires is granted an order . . . it should be placed under the obligation to remove these overhead wires within a period of two years from the granting of the order.' At Eastbourne this plan has stood the test of seven years' experiment most satisfactorily. For all these reasons the committee recommends that all wires should be placed in proper channels underground.

"Although the details for this scheme are set out, estimates of the cost could not be made until the site of the proposed central lighting station was determined. From the certainty that very large quantities of coals would have to be used to generate the electricity, and that condensing-engines could be worked more economically than other

kinds, your committee was of opinion that a site where coals could be delivered in railway trucks, and a supply of water sufficient for condensing obtained gratis, would be the best. As, however, the Council had no such site, and your committee, not wishing to delay this report, elected to name as the site the vacant land off Back George's-street, at the back of Millgarth-street police station. This decision was the more readily arrived at as, whatever the site, the capital required for the installation would be about the same; the cost of coal delivery, and the saving effected by condensing steam only affecting the cost of working.

"Using these conclusions as a basis, your committee has obtained tenders from several of the most successful electric lighting companies for carrying out the lighting of the district previously described. These tenders include buildings and machinery, erected so as to admit of extension, chimney-shaft, and all costs of providing and fixing cables, transformers, and meters; in short, the total cost of the installation for 37,500 10-c.p. lamps complete, leaving each customer, however, to pay for fitting up his own premises and connecting to the mains, as in the case of an ordinary gas supply. Averaging these tenders, and adding the value of land and other necessities not included in the tenders, together with 5 per cent. for contingencies, the total cost amounts to the sum of £58,000. Whilst there can be no doubt as to the suitability of the district chosen, your committee would point out that, from the nature of the business of that district, a large demand for the light will not extend far into the evening, and that, consequently, the initial or extra cost of getting up steam and maintaining it during the hours of small demand will make the cost of production more than if, in addition to the district chosen, there could be added a considerable number of private residences which would take up the demand as places of business and shops ceased. This feature could be added to the scheme already described by laying down mains to residential portions of the borough. This would cost an additional £10,000, making with the £58,000 required for the central town scheme, £68,000. Whilst the latter amount would be required to carry out the whole of the scheme described, it must be remembered that, as is seen from the description of the places visited, an electric lighting station consists of a unit or initial plant, multiplied from time to time as the demand for the light increases. For this reason your committee would not advise this central lighting installation for Leeds to be, in the first place, larger than would involve an expenditure of £25,000.

"As to the cost of the electric light to customers, the charges made by the most modern company (West Brompton), working on the new lines of a high potential, are as follows: (1) At the rate of 1s. per Board of Trade unit* for the first 100 hours' consumption of the maximum supply demanded; (2) at the rate of 8d. per Board of Trade unit for the second 100 hours' consumption of the maximum supply demanded; (3) at the rate of 4d. per Board of Trade unit for any further quantity consumed. Rent of meter, instruments, etc., 5s. per Board of Trade unit of maximum supply demanded per quarter.

"The charge made by the leading London companies upon their customers, works out to one farthing per hour per 10-c.p. lamp; and this, of course, includes their profits. Your committee's experience on this head is, that the nett cost of the 16-c.p. lamp (the size used in the existing installation) is only one farthing per lamp per hour.

"Looking at the smallness of this installation, compared with a large central lighting station for the town, the committee is of opinion that an incandescent 10-c.p. lamp can, after paying for depreciation and interest, but not making a profit, be run for $\frac{1}{2}$ of a penny per lamp per hour. Comparing this with the present price of gas in Leeds, electric lighting can be supplied at 20 per cent. above that price; but as the customers would have, in addition to pay for renewing their lamps, this would probably add 40 per cent. to the total cost, according to the present price, or taking gas and meters at 2s. per 1,000ft., the electric light

* A Board of Trade unit (1,000 watt-hours) may be estimated to supply about 20 incandescent lamps of 16 c.p. (or an equivalent number of lamps of smaller c.p.), for one hour.

would be equal to the price of gas at 3s. 5d. per 1,000ft. It is left to others to calculate the indirect but great advantages of electric lighting when compared with gas lighting, as affecting health, goods, furniture, books, decorations, etc., and the absolute freedom of the electric light from explosions and personal injury.

"Having given the Council the details and cost of a scheme for central lighting, your committee has to remind the Council that the amendment of the Electric Lighting Act, 1888, was made specially with a view to the speedy introduction of electric lighting into towns; and to offer facilities and greater inducements to private companies to undertake such lighting where corporations will not do so. Further, that the Board of Trade has power, and has shown itself willing, to grant licenses to private companies to undertake the lighting of towns where corporations are unwilling or delay to do so, and further, that applications have already been made to your committee for its consent to private parties undertaking the lighting of the town.

"To sum up, your committee concludes as follows: 1st. That it is desirable to keep the control in its own hands of what may prove eventually a very important business, deeply affecting the duties and responsibilities of the Council. 2nd. That the committee can undertake electric lighting, at a cost to the consumers of (say) $\frac{1}{8}$ of a penny per lamp per hour, whilst a company could only do so at a cost to the customer of double that price, i.e., $\frac{1}{4}$ of a penny per lamp per hour. 3rd. That should a company undertake the lighting, any saving in the cost of production would not at once benefit the consumers, as it would only be given at the termination of periods of rest of probably seven years. 4th. That as a company, under the Act of Parliament, would have powers lasting 42 years, it is not desirable to give such company possession of the streets of the borough for so long a term, and with statutory powers which would interfere with any other new service requiring the use of the streets. The Council has already had experience of this in regard to the tramway company and the late gas company. 5th. That, although it is competent for the Council under the Act of Parliament to agree with a company for a shorter term than 42 years, this can only be done by granting compensating advantages to the company.

"Finally, the committee resolved: 1st. That the report now read be adopted, and a copy forwarded to each member of the Council. 2nd. That the Council be recommended to light by electricity such portions of the Town Hall and municipal buildings as are described in the report, at an estimated expenditure of £3,000. 3rd. That the Council apply to the Board of Trade for a provisional order under the authority of the Electric Lighting Acts, 1882 and 1888, authorising the Corporation, as the local authority under the Acts, to provide and supply electricity for public and private lighting purposes within the area referred to in the report, at an estimated total capital expenditure of £68,000, and that the town clerk (in conjunction with the Electric Lighting Committee) be authorised and empowered to take all necessary legal and other proceedings, and to give all notices on behalf of the Council, which may be necessary in connection with the application to the Board for and obtaining such provisional order. 4th. That the Council authorise the Electric Lighting Committee to carry out and complete an initial installation of electric lighting within the district mentioned in the report, at an estimated capital expenditure of £25,000, such sum being part of the sum of £68,000, to be borrowed under the authority of the provisional order. 5th. That the chairman be requested to give notice of the necessary resolutions to be moved at the next meeting of the Council for carrying the foregoing recommendations of the committee into effect.

"LEEDS TOWN COUNCIL.

"July 3, 1889.

"The recommendation of the committee No. 2 was adopted.

"Recommendations Nos. 3 and 4 were referred back to the committee to report further, especially as to the annual cost of the present installation and the cost of installations in other towns."

NOTES ON ELECTRIC LIGHTING.*

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[Electric light engineers and supply companies are apt at times to look at all questions of light and power distribution from their own point of view. Their knowledge of the subject is, of course, one-sided, and many of its phases appear different to the local authorities. When harmony prevails, business frequently results. It is thus important that electric light engineers study carefully the position as put forward by those who have to advise the local authorities, and to make straight and correct the points in which the advisers go astray through insufficient knowledge or any other reason. Hence such papers as that given below are important.—ED. E. E.]

INTRODUCTORY.

Several papers on electric lighting appear in the *Proceedings* of this association, but they were, with one exception, all delivered by non-members, and the discussions which followed them were very meagre; this fact tends to show that the members generally did not on those occasions take that interest in the subject which it demanded. As, however, electric lighting may now be said to have passed the experimental stage and reached the practical, and recent legislation, by extending the time before local authorities can compulsorily buy up the undertakings of private companies, has removed the only bar which for the last year or two has prevented capitalists from entering the field, this indifference should not be allowed to continue.

We may expect in the very near future that central lighting stations will be established in most of our large provincial towns as they are now being established in the metropolis and other places. Our clients are in most cases interested either as a body or as private individuals in gas works, and, therefore, it is probable that in many towns corporations will not themselves run electric lighting stations; this, however, will not prevent private companies being started, as the Board of Trade has now power to grant provisional orders to companies where corporations refuse or neglect to undertake the work. These private companies will come into our midst; they will break up our streets, interfere with extensions of our sewers, drains, gaspipes, and water-mains, and generally ride roughshod over public and private rights, unless they are duly restricted when obtaining their Parliamentary powers.

To whom, then, must our corporations look to advise them in obtaining these proper restrictions? There is no official connected with our municipal governments, except the borough engineer, who is at all competent to cope with this question; and undoubtedly it is the duty of every one of us to make ourselves masters of the subject, so that when the time comes we shall be able to advise our respective clients in this matter as we should do in any other engineering undertaking. Our duties extend further than this: when once a company is started in any town, one of the first places that the undertakers will seek to light will be our municipal buildings and streets, and the borough engineer will be called upon to design the consumer's part of the work of installation; and in some cases, where the corporations take up the central station lighting themselves, we may be called upon to design the works of supply.

There is also another view of the question: the work of the profession is generally under-estimated; no doubt this arises from what is ignorantly deemed the ordinary nature of our work, and its want of special character. By adding to the duties of the borough engineer that of electric lighting, a natural addition to his work will be made which will be deemed extraordinary, and so to some extent act as a set-off against the want of appreciation in

* A paper read at the Annual Congress of the Association of Municipal and Sanitary Engineers and Surveyors, Portsmouth, 4th, 5th, and 6th July, 1889.

other respects. The alternative to the borough engineer doing this work will be that electrical engineers will be called in, and we shall see a new department formed in our towns, the work of which should naturally, and will ultimately, come into our hands; the latter event, however, not taking place until the work has become ordinary, and all benefit from the introduction of the work has passed away.

This view of the question, together with the rapid strides which the science of electric lighting has made since the last paper was read, induced the author to bring the subject again before the association. He does so with the feeling that the time to which he is limited is quite inadequate to cover all the ground; but as he has made a special study of the question, and passed an examination of the City and Guilds of London Institute, and had practical experience in the work, he deems it a duty at this juncture to give to the association all the information he can upon the subject.

This he proposes to do by giving the following leading features and the particular points to be noted in electric lighting installations:

UNITS OF PRODUCTION.

Before going into any detail of construction, it may be well to say something as to the broad lines on which an installation is designed. The first point to be considered is the number of lamps required; and here a word of warning must be said—viz., "be liberal." The public generally expect more of electric light than they do of gas. They look upon electric lighting as something very brilliant; and if, in replacing gas, the same number of candle-power only is provided, the public will be disappointed. Incandescent lamps are usually of 16 c.p. and 8 c.p., but to avoid confusion we will consider all lamps to be 16 c.p. Each lamp requires about 50 to 55 watts of energy to supply it with light to give a fair life of, say, 1,000 hours.

Arc lamps as a rule are made of 2,000 c.p. nominal, but the actual available light is about half that amount; they usually take a current of 10 amperes at 45 volts potential to run them, or 450 watts.

We have now a means of determining the amount of power required for any installation; take the number of incandescent lamps and multiply by, say, 55, and the number of arc lamps multiplied by, say, 500, and the sum will be the total number of watts required. Divide this total by 746, the number of watts in a horse-power, and we have the e.h.p. which must be produced by the dynamo. To this must be added 10 to 15 per cent. loss in dynamos and mains, and we then get the aggregate brake horse-power which the engines must transmit to the dynamos. Clearly for safe working this power must not be all concentrated in one engine and dynamo. The next point, therefore, to be considered is the sizes of the engines and dynamos to produce this power, or the producing units, and this is a point which requires very careful consideration. As a rule, it is best, as will be seen later, to keep arc lights and incandescent lamps separate, and to so arrange the units that there is always an engine and dynamo standing idle in case of a breakdown.

Assuming a case where 100 h.p. is required from the engines for incandescent lighting only; a good arrangement in such a case would be to have five engines and dynamos, each normally working 25 h.p., but capable of giving off 33 h.p. if required—there would then be provision for a double breakdown with only 25 per cent. more plant than actually required.

ENGINES.

High-speed engines coupled direct to the dynamo offer great advantages. They take up little room, and avoid all losses of transmission by belting or other methods of gearing. Steam-engines are always to be preferred to any other form of motor in large installations, unless water power is available, but good work can be done by gas-engines. The most important point about the engine, of whatever type it may be, is that it shall be well governed. Electric lighting can never be successfully accomplished unless the engine runs at a perfectly uniform rate at all loads. Engines are not unfrequently governed electrically, but there are several mechanical governors which are very satisfactory,

and electrical engineers seem very divided in their opinion as to the advisability of using electrical governors.

Gas-engines are very convenient for small installations, as they can be so readily started at a moment's notice, and can often be introduced into positions where steam-engines would be inadmissible; but for large installations, the gas bill is too heavy in comparison with the coal bill of a steam-engine. When gas-engines are used they should be provided with heavy flywheels, as should also the dynamos worked by them, and they should be worked as nearly at full power as practicable, as they run much more steadily with heavy loads than when running light.

DYNAMOS.

Dynamos may be said to be divided into three classes, known respectively as series, shunt, and compound-wound dynamos. Series dynamos are used for arc lighting, and are so called because the main current from the commutator is taken round the magnets and used as the exciting current. Shunt dynamos are used for charging secondary batteries principally, and are so called because the exciting current is a shunt taken off the main current on leaving the commutator. Compound-wound dynamos are used for incandescent lighting; the term compound is applied because the magnet winding is composed of two parts combining the windings of the two previous classes.

The principal difference in these three windings is that the series winding produces a constant current, but the E.M.F. can be varied by altering the speed of the engine. This is exactly the condition required for arc lamps, which are nearly always arranged in series. When, therefore, more lamps are put in circuit the E.M.F. can be raised whilst still keeping the original current. Shunt dynamos are used for charging batteries, because if the engine slows down and the E.M.F. of the dynamos falls below that of the batteries, and the current is reversed in the armature, the electrification of the magnets is still such as to oppose an E.M.F. to that of the batteries, thus preventing a sudden rush of current through the low resistance of the armature, which would be followed by burning of the armature winding. Compound-wound dynamos are used for incandescent lighting. The object of the compounding is to keep a constant E.M.F. with a varying current. Incandescent lamps are nearly always arranged in parallel, so that as more lamps are switched into circuit the current increases; but it is of the utmost importance to keep the E.M.F. constant, as the effect of a very small rise of E.M.F. on the lamps is very injurious. Theoretically, a compound-wound dynamo should give a constant E.M.F., whether there is one lamp in circuit or the maximum number, but in practice it is usual to give a slight increase of E.M.F. as the current increases to compensate for the resistance of the wires.

The most important point about a dynamo is its efficiency; there are several dynamos in the market to-day which give a commercial efficiency of 90 per cent. and even higher. It is a great mistake to economise to the extent of a few pounds in the first cost of a dynamo if that economy is at the expense of the efficiency.

And here a few words may be said in praise of electrical engineers. It is to their credit that machines can be purchased giving an efficiency of 93 and 94 per cent., that is to say, for every 100 h.p. transmitted to the dynamo from the engine 93 or 94 are returned in the shape of electrical energy for utilisation outside the machine. It is only a few years since dynamos were first made commercially, and yet we have now in our hands machines which are more perfect than any other type of machine.

The turbine is perhaps the next most efficient engine, but the best turbines do not give more than 75 per cent. efficiency.

An instance of the rapid improvement in electrical machinery may be given. The author was connected with an installation put down in 1883, the dynamos of which were considered good at that time. They gave an efficiency of about 66 per cent., and to-day they are working side by side with dynamos which were delivered under contract to give an efficiency of 94 per cent.

The efficiency of a dynamo is measured by taking the E.M.F. between the terminals with a voltmeter, and the

number of amperes with an ammeter in the external circuit, these two quantities multiplied together and divided by 746 give the e.h.p. in the external circuit. This quantity must then be compared with the brake horse-power delivered to the dynamo by the engine at the time the test is taken—the ratio of these two quantities gives the efficiency. These tests of efficiency should extend over various loads up to the maximum. A further test should be made at full load for a period of not less than 12 hours, during which time the temperature of the magnet winding should be taken, and at the end of the run the temperature of the armature-coils. As a rough test, no part of the dynamo should ever be so hot that the hands cannot be pressed on it without inconvenience. It is, of course, important to see that the bearings are large enough, well lubricated, and do not run hot, and there should be no sparking at the brushes.

Dynamos, if not coupled to the engine direct, should be fixed on wood frames, and it is convenient to have a screw and ratchet attachment to take up the slack of the belt. In all cases the dynamo should be thoroughly insulated from earth, and the insulation of the magnet and armature-coils should be as perfect as possible. In specifying for dynamos the type of winding should be given, and the output in amperes and volts, and the required standard of efficiency, instead of adopting the common method of specifying for a 100-light dynamo or a 500-light dynamo, as the case may be. To speak of a dynamo as a hundred-lighter is all very well for ordinary conversation, but it is quite a different thing to reject a dynamo as unsatisfactory if specified for in that way; it may be possible to light 100 lights with it in a way, but it is far better to make it quite clear what the output is to be.

High speeds are to be avoided in dynamos, as they occasion trouble with bearings, excessive wear on commutators and brushes, and heating and great mechanical stress in the armature winding, to say nothing of the necessity for small pulleys and tight belts, with the consequent loss of power by slipping and extra stresses put on bearings. As a limit, perhaps 1,000 revolutions per minute is as high as the speed should reach, and it is much better to have a larger machine, costing perhaps a little more and running at a slower speed. It is important that dynamos should not be fixed in rooms where there is likely to be much dust, or where any "hazardous process" is carried on, or where any "hazardous goods" are stored. The dynamo station should be well supplied with suitable meters. To every dynamo there should be an ammeter for measuring the current, and a voltmeter should be so arranged that the E.M.F. of every circuit can be measured. The dynamos and engines should be specified to run so steadily that a difference of potential amounting to $1\frac{1}{2}$ per cent. up or down should not be exceeded.

WIRING.

The wiring of an installation is somewhat analogous to designing a system of water-mains for a town supply. There are the main cables, which diminish in size as the branches are taken off, there are switches to cut out any branch or the whole supply, and there are safety valves in the shape of fuses. All wires should be so proportioned that the current passing through them should never exceed 1,000 amperes per square inch of sectional area of copper, and the difference of potential between the terminals of any two lamps should not exceed 4 per cent. the total E.M.F. There should be, further, a relationship between the cost of conductors and the cost of power expended in overcoming their resistance. Sir W. Thomson's rule is that the interest and depreciation on the capital account for cables should be equal to the cost of the energy absorbed by their resistance.

The copper should be specified to have a conductivity of not less than 96 per cent. of pure copper. The material forming the insulation is a somewhat vexed question. The class of cable mostly used consists of stranded copper wires tinned and wrapped in cotton. This is covered with three coats of vulcanised rubber. The cable is then braided with hemp and the whole immersed in a bituminous compound. Guttapercha is used as an insulating material, but it is unsuitable for positions where the cable is liable to much change of temperature, as the guttapercha softens

and the weight of the copper core causes decentralisation, which in time destroys the insulation entirely. In cases where cables are to be laid underground, lead-covered cables are very useful, but they are liable to chemical action where they come in contact with vegetable acids.

Indiarubber is made of very different qualities, ranging from 1s. to 3s. per pound in price; it is therefore very necessary to be careful to specify that only the best quality of that material is used. The following is the Admiralty test: Take a portion of the indiarubber and place it in a steam chest under a pressure of 60lb. of steam (about 300deg. F.), and keep it there for three hours. Remove, and put in a dry heat at 270deg. F. for two hours, and then allow to cool. If the rubber is then soft and cools without cracking the quality is good. The chemical constitution should be specified and tested by analysis. The sulphur should never exceed 3 per cent., as it attacks copper very freely. The oxide of zinc need not be less than 40 per cent., and if used in a soil or for a purpose where it may be subjected to mineral oil, this oxide should be at least 60 per cent.

In testing for insulation two facts should be borne in mind, 1st, that a high initial insulation is no criterion of the durability of the material; and 2nd, that the insulation of the cables and of the installation as a whole are two very different quantities. It is therefore very advisable to specify that the contractor shall stand by the insulation for as long as possible. Eminent electricians say five years is not too long. The reason why the insulation of the installation as a whole and of the cables are distinct and separate is this, that there is often, especially in damp weather, a large amount of surface leakage going on at fittings and joints which makes the insulation of the whole installation very low. Now, if this leakage, instead of being in the fittings, were chiefly in the cables, it would show that they were very defective, and that a fault would occur in them sooner or later. It is necessary, therefore, to test the cables before fixing, and Prof. Jamieson, of Glasgow, adopts the following rule—viz., one megohm per lamp for every volt, the coils being submerged in water not less than six hours, immediately before and during the tests. If the coils do not considerably exceed that minimum, they are subjected whilst in water to an E.M.F. 50 per cent. greater than the proposed working E.M.F., and again tested. The insulation resistance of the installation complete must be tested, and the same authority gives us the following rule:

$$R = K \frac{E}{N};$$

where R = resistance of insulation of circuit or of generator in ohms;

K = a constant found by experiment from good examples = 100,000;

E = E.M.F. of installation in volts;

N = number of lamps (16 c.p.) in circuit.

This gives us a value for the insulation of the circuit or of the generator, and therefore the insulation resistance of the two in parallel should be half that amount. This test should be made after the trial run, when, if there should be any weak places in the insulation, the working potential will have had an opportunity of finding them out, and also the surface leakage from fittings, etc., will be at a minimum.

Great care must be taken to ensure good joints. Every joint should be made electrically and mechanically perfect. The two cables to be joined should be in stranded and interwoven one with another, then soldered, and then the insulation should be made good with proper insulating materials of the same class as those of the original cables.

In wiring public buildings it is advisable, if possible, to arrange the lamps on two circuits, in such a way that, should any accident take place, only half the lamps in each room will be extinguished, and this method lends itself to what is known as the three-wire system, in which one of the main cables is a sort of intermediate cable doing duty for both dynamos, thus effecting an economy in first cost, and also in working expenses. All cables inside buildings should, where possible, be laid in grooves ploughed in well-varnished boards, and where wires pass from one building to another, or through thick walls, they should be enclosed

in cast-iron pipes. In no case should wires be buried in plaster. The cables, on leaving the dynamos, should be all collected to a switchboard, on which are placed the meters and suitable arrangement for switching the different dynamos on to the various circuits. Every main cable, branch cable, and lamp, or group of lamps, should be provided with a switch for turning the current on and off, and with a safety fuse to prevent the current rising more than 25 per cent. above the normal current. All switches and fuses should be fixed on slate, porcelain, or other incombustible bases, and fuses should, if possible, be enclosed in incombustible boxes.

A revised set of rules for the fitting up of installations to prevent fire risks have been recently drawn up by the Institution of Electrical Engineers, and they should be incorporated in all specifications for contract work; but, as several of the fire insurance offices have rules of their own, it is necessary, if the buildings to be lighted are insured in one of those offices, to specify for their rules to be carried out in addition to those of the Institution of Electrical Engineers.

LAMPS.

Incandescent lamps should as a rule be used for interior lighting. For large public rooms it is usually convenient to group the lamps together on chandeliers suspended from the ceiling; for lighting private houses, offices, reading-rooms, etc., where the light must be concentrated in particular places, the lamps can be arranged in groups of two or three or singly, in the same manner as ordinary gas-burners.

Incandescent lamps are usually of 16 or 8 c.p., although, as previously stated, people expect more of electric light than they do of gas, as a matter of practical experience the author has found that given a room or shop satisfactorily lighted with gas, which it is desirable to replace by reason of the injury to goods, decorations, health, etc., an 8 c.p. incandescent lamp substituted for each gas-burner will equally light the premises.

The author found that a public reading-room 80ft. by 34ft., lighted with 72 16-c.p. lamps in groups of three, equal 4.2 square yards per lamp, the lamps being 9ft. 3in. above the floor, was not well lighted, also that another public reading-room 96ft. by 31ft., lighted by 56 lamps fixed 8ft. 9in. above the floor, equal six square yards per lamp, was well lighted. This apparent contradiction could only be accounted for by the colour of the wall; in the former case the walls were of a dark green colour of encaustic tiles, with a roof of dark brown and red mosaic, and in the latter the walls were cream colour and the ceiling dead white. In a large public hall, 130ft. by 71ft. and 72ft. high, the author found that seven electroliers, each bearing 56 16-c.p. lamps, at an average height of 30ft. above the floor, gave but a poor illumination; the same room was subsequently satisfactorily lighted in point of quantity of light with eight 2,000-c.p. arc lamps. In a recent built art gallery at Leeds lighted entirely by electricity, 16-c.p. lamps are placed in groups of four at 7ft. from the walls, in galleries 28ft. wide, and at a height from the floor of 8ft. 9in., and have been found very successful 5ft. 4in. apart. In galleries of the same dimensions groups of seven lamps, placed the same height from the floor and 6ft. apart, have also been found satisfactory.

Incandescent lamps are made of various resistances, requiring E.M.F.'s ranging from 40 to 100 volts. On installations of any size 100 volts lamps should be used. The lamps are always arranged in parallel, though occasionally they are arranged in parallels of two lamps in series. Owing to recent litigation there is practically no choice of lamps in the market at the present time. Lamps should never be run at a greater efficiency than 3 to 3.5 watts per candle, or the interior of the glass bulbs will soon become clouded by partial combustion of the filament, with a consequent loss of light, and the light of the lamp becomes shortened. Incandescent lamps have been tried for street and outdoor lighting, and proved an utter failure; on the other hand, for such positions the arc lamp is most suitable. For railway stations, covered markets, and similar places, the lamps may be suspended from the roof in convenient places, but always so high up that the lamps will not fall

within the field of vision. In large open spaces the lamps may be suspended from masts. In street lighting a 2,000 c.p. arc lamp will light up a radius of 80 yards when placed over the centre of the street, but only two-thirds of that distance when placed against the buildings. The necessity for arc lights placed in the centre of the street being high enough to allow of the passing of a fire-escape is not of vital moment, as at most it will be only 25 feet, whereas the light is sufficient for 80 yards.

The renewal of the carbons in arc lamps has to be done every 16 or 32 hours. To do this readily in markets, railway stations, etc., the lamps should be suspended by electric leads passing over pulley blocks, to one of which should be attached a counterbalance weight, and the number of sheaves in the blocks be such that the weight will not fall below the lamp when in position. For lamps suspended over the centres of streets the counterbalance weight can be arranged to run up and down the supports, and the cord for raising and lowering placed out of reach of foot passengers; the only inconvenience which arises from this method is the possible interference with traffic in crowded thoroughfares for the short time the attendant occupies in lowering the lamps and fixing the carbons, and that at most once a day. The number of arc lamps in the market is legion, and great care must be taken in selecting a lamp which will give a steady light. Lamps should be focussing, and provided with an automatic cut-out, the regulating machinery should be simple, strong, not liable to get out of order, and well protected from the weather. Arc lamps are nearly always arranged in series, the number on one circuit varying from 3 to 50, according to the E.M.F. available. If the number of lamps in series be less than three, they will not run steadily unless a resistance is put in circuit as a sort of flywheel. The author has found that one lamp will run with a resistance of 1.5 ohm in circuit, and two lamps with a resistance of 2.5 ohms. These resistances, of course, mean loss of energy, and they are therefore undesirable, but it often happens that the lamps can be usefully employed on an incandescent system, and they can be made to run in that way. Good carbons are a necessity for steady running, and the best results are obtained with cored positive carbons and solid negative carbons 13mm. diameter.

(To be continued.)

COMPANIES' MEETINGS.

UNITED TELEPHONE COMPANY.

An extraordinary general meeting of the United Telephone Company was held on Thursday, the 4th inst., at the City Terminus Hotel, to consider the confirmation of the resolutions passed at the meeting on the 4th ult. for approving the agreement between the Company and the National Telephone Company for amalgamating the two companies, winding up the Company, appointing liquidators, etc.

Mr. James Brand, who presided, stated that since the last meeting the only matter of importance that had occurred had been the receipt by the Secretary of a letter addressed to the Company by the Postmaster-General. This letter had been published in the newspapers, and no doubt, therefore, the shareholders had seen it, as well as the reply to it on the part of the Directors, who felt that they had the best of the correspondence. Since then the Postmaster-General had written another letter, which had also been published, but to which the Board had not deemed it necessary to reply, thinking it better to leave the public to form a judgment as between the telephone companies and the chief of the Post Office. The Directors were doing what they believed they had a perfect right to do. They were not seeking to interfere with the Postmaster-General or the Government in any way. Their object in amalgamating was to make themselves stronger financially, and in other ways, and they also wished to give a better and cheaper telephonic service to the public.

On the motion of the Chairman, seconded by Mr. J. S. Forbes, the resolutions were unanimously passed *seriatim*.

The Chairman then said it was his painful duty to wish the shareholders good-bye as Chairman of the Company, a position which he had occupied from the outset of its existence. Before that period he was chairman of the Bell Telephone Company, he and a few friends having purchased the wonderful instrument from Prof. Bell. Finding it impracticable, however, for the commercial working of the exchange system, they joined with Mr. Edison and that gentleman's friends, and bought up the property of the Blake transmitter. Since then they had worked under the title of the United Telephone Company, the shares of which he had had the pleasure of seeing rise from £5 to £15, and the dividend from scarcely anything to 17½ per cent. On

the new Company they would have an excellent Board, composed of men well qualified to conduct affairs successfully.

Several of the Directors and shareholders expressed surprise and regret at the announcement of his resignation by the Chairman, who ultimately stated that he would let matters stand as they were for the present.

NATIONAL TELEPHONE COMPANY.

An extraordinary general meeting of the National Telephone Company was held on Thursday, the 4th inst., at the City Terminus Hotel, Colonel R. Raynsford Jackson presiding, to consider the confirmation of the resolutions passed at the meeting on the 4th ult., adopting agreements between the United Telephone Company, Limited, and the Company and the Lancashire and Cheshire Telephonic Exchange Company, Limited, and the Company for the transfer of the businesses of the United and the Lancashire Companies to the National Company; increasing the capital of the Company by the issue of 650,000 new shares of £5 each; adopting new regulations for the Company, and removing the existing Directors.

The Chairman submitted the resolutions separately. He stated, in answer to Mr. Buchanan, that the recent correspondence in the *Times* on the part of the Post Office had caused the Directors no anxiety, and had not influenced them in departing from the course which they had already mapped out for themselves. Neither did they think there was any reason why the shareholders should trouble themselves in the matter. He anticipated that the Postmaster-General would content himself with the protest he had made, and, probably, if hereafter he resolved to buy the telephone companies' undertaking he would refer the matter to arbitration. If the Postmaster-General should resolve at the first break in the period of the license to buy the telephone systems the price to be paid would have to be fixed by an arbitrator, and he (the speaker) had no doubt that the Postmaster-General was preparing for himself a series of arguments to influence the arbitrators' decision.

Mr. F. R. Leyland (a Director) said they had consulted Sir Horace Davey, Q.C., M.P., and Mr. Rigby, Q.C., whose advice was that there was nothing whatever in the license that would be infringed or affected in the slightest degree by the proposed arrangements being carried out.

The resolutions were confirmed.

On the motion of Mr. W. A. Smith, a resolution was afterwards passed appointing as Directors of the Company, Messrs. C. A. Agnew, J. W. Batten, J. Brand, J. Bruce, J. S. Forbes, P. Garnett, Eli Heyworth, F. R. Leyland, J. B. Morgan, D. Parrish, W. C. Quilter, M.P., G. H. Robertson, and S. H. Sands, Colonel R. R. Jackson, and Alderman J. Thompson.

NEW COMPANIES REGISTERED.

Liverpool House-to-House Electricity Company, Limited.—Registered by Slaughter and May, 18, Austinfriars, E.C., with a capital of £100,000 in £5 shares. Object: to form centres in Birmingham at which electric power may be generated, accumulated, and distributed. The first subscribers are:

	Shares.
R. Hammond, 117, Bishopsgate-street, E.C.	1
C. Cornish, 132, Belvedere-road, S.E.	1
J. Whitehead, Heycot, Crouch End	1
T. Towerson, F.C.S., 1, Portland-road, Finsbury Park...	1
W. Bingham, C.E., 7, Bedford-place, W.C.	1
H. Linklater, 117, Bishopsgate-street, E.C.	1
H. Mann, 12, Woburn-place, W.C.	1

There shall not be less than three nor more than seven Directors. Qualification: £250 stock. The holders of the founders' shares will be entitled to elect the Directors, and the House-to-House Electric Light Supply Company will also be entitled to be represented on the Board. Remuneration: £500 and one-tenth of net profits after 7 per cent. dividend.

South of England House-to-House Electricity Company, Limited.—Registered by Slaughter and May, 18, Austinfriars, E.C., with a capital of £100,000 in £5 shares. The subscribers and arrangements for management are identical with the preceding company.

Western House-to-House Electricity Company, Limited.—Registered by Slaughter and May, 18, Austinfriars, E.C., with a capital of £100,000, in £5 shares. The subscribers and arrangements for management are identical with the preceding companies.

Yorkshire House-to-House Electricity Company, Limited.—Registered by Slaughter and May, 18, Austinfriars, E.C., with a capital of £100,000 in £5 shares. The subscribers and arrangements for management are identical with the preceding companies.

Manchester House-to-House Electricity Company, Limited.—Registered by Slaughter and May, 18, Austinfriars, E.C., with a capital of £100,000 in £5 shares. The subscribers and arrangements for management are identical with the above companies.

Midland House-to-House Electricity Company, Limited.—Registered by Slaughter and May, 18, Austinfriars, E.C., with a capital of £100,000 in £5 shares. The subscribers and arrangements for management are identical with the above companies.

Northern House-to-House Electricity Company, Limited.—Registered by Slaughter and May, 18, Austinfriars, E.C., with a capital of £100,000 in £5 shares. The subscribers and arrangements for management are identical with the above companies.

Scottish House-to-House Electricity Company, Limited.—Registered by Slaughter and May, 18, Austinfriars, E.C., with a capital of £100,000 in £5 shares. The subscribers and arrangements for management are identical with the above companies.

Kingston-upon-Hull Electric Lighting and Supply Company, Limited.—Registered by F. B. Moss, the Outer Temple, Strand, W.C., with a capital of £1,000 in £1 shares. Object: to establish at Kingston-upon-Hull an electric light company. Registered without articles of association.

Schoth's Electro-Medical Apparatus Company, Limited.—Registered by Danell and Co., Finsbury-chambers, E.C., with a capital of £10,000 in £1 shares. Object: to carry on all the businesses hitherto carried on by G. A. Schoth, of Euston-road, for manufacturing electro-medical and scientific instruments, and also the manufacture of medical and surgical instruments. Registered without articles of association.

Henley Telegraph and Electric Construction Company, Limited.—Registered by Newman, Hays, and Co., 31, Abchurch-lane, E.C., with a capital of £200,000 in £10 shares. Object: to carry on, as principals or agents, the business of electricians, telegraph engineers and contractors, submarine and telegraph instrument manufacturers, etc., and for the purpose to acquire lands, works, property, and premises wherever convenient, and the machinery and patent rights belonging to W. T. Henley's Telegraph Works Company, Limited, and the goodwill, property, and other rights connected therewith; to carry on the business of an electric light company in all its branches, and in particular to erect any works requisite for the business of the Company wherever expedient and convenient. The first subscribers are:

	Shares.
F. Newton, 16, King William-street, E.C.	1
W. Hays, 31, Abchurch-lane, E.C.	1
H. Lescher, 6, Clement's-lane, E.C.	1
Lient.-General Sir J. Stokes, K.C.B., Good Rest, Haywards Heath 1	
S. Gedge, M.D., 1, Old Palace-yard, Westminster	1
G. Baird, C.E., Travellers' Club, Pall-mall	1
The Hon. H. S. Littleton, 22, Rutland-gate, S.W.	1

There shall not be less than three nor more than nine Directors. The first to be appointed by the subscribers to the memorandum of association. Qualification, 50 shares. Remuneration: £2,000, and further £150 for every 1 per cent. of dividend over 10 per cent.

Chili Telephone Company, Limited.—Registered by Slaughter and May, 18, Austinfriars, E.C., with a capital of £250,000 in £5 shares. Object: to carry into effect an agreement made between W. A. Pittman and the Chili Telephone Company, Limited, and to purchase, acquire, construct, equip, maintain and work any lines of telegraph, telephones or other means of communication in Chili and the adjoining countries, and generally to carry on the business of a telegraph, telephone and electric light company. The first subscribers are:

	Shares.
W. C. Slaughter, 18, Austinfriars, E.C.	1
W. A. Pittman, 7, St. Helen's-gardens, S.W.	1
H. Mann, 12, Woburn-place, W.C.	1
F. Bolter, 31, Ampton-street, W.C.	1
E. Griggs, Morland Cottage, Bromley	1
J. R. Carter, 2, Steeles-road, Haverstock-hill	1
H. L. Cole, 14, King's Arm-yard, E.C.	1

There shall not be less than three nor more than seven Directors. The first to be appointed by the subscribers to the memorandum of association. Qualification: £1,000 stock. Remuneration to be determined in general meeting.

Peru Telephone Company, Limited.—Registered by Slaughter and May, 18, Austinfriars, E.C., with a capital of £100,000 in £5 shares. Object: to carry into effect an agreement made between W. A. Pittman and the Peru Telephone Company, Limited, to acquire any lines of telegraphs and telephones in Peru. The first subscribers are:

	Shares.
J. D. Pearson, 3, Oakleigh-road, Southgate	1
H. E. Warner, Beecheroff, Streatham	1
W. A. Pittman, 7, St. Helen's-gardens, S.W.	1
H. Mann, 12, Woburn-place, W.C.	1
W. Capel Slaughter, 18, Austinfriars, E.C.	1
W. May, 18, Austinfriars, E.C.	1
S. E. Prett, 18, Austinfriars, E.C.	1

There shall not be less than three nor more than seven Directors. Qualification, £1,000 stock. Remuneration to be determined in general meeting.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for the week ended July 5 amounted to £4,068.

Great Northern Telegraph Company.—The traffic receipts of this Company for the month of June amounted to £22,600.

National Telephone Company, Limited.—The registered offices of this Company have been removed to Oxford-court, Cannon-street, London, E.C.

Telegraph Construction and Maintenance Company, Limited.—An interim dividend of 12s. per share has been declared by this Company, payable July 16.

Edison and Swan United Electric Light Company.—The Directors of this Company have, subject to audit, decided to recom-

ment a dividend of 7 per cent. for the year ending June 30, on the "A" shares, and a further distribution of 3 per cent. against arrears of cumulative preferential dividend on those shares.

Cuba Submarine Telegraph Company.—The estimated receipts of this Company for June were £3,300, as compared with £3,027. The receipts for March, estimated at £4,500, realised £4,540.

West Coast of America Telegraph Company.—The Directors of this Company have declared an interim dividend of 5s. per share, tax free, in respect of the first half of 1889, payable on the 18th inst.

Western and Brazilian Telegraph Company, Limited.—The receipts for the week ended July 5, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,791.

Eastern Telegraph Company, Limited.—This Company announces that, subject to the final audit, the accounts show, after placing about £118,000 to reserve fund, a balance available sufficient to pay the fixed dividend of 3s. per share, being at the rate of 6 per cent. per annum on the preference shares, less income tax, and a final payment of 2s. 6d. per share, with a bonus of 3s. per share, both free of income tax, on the ordinary shares, making, with previous payments on account, a total distribution of 6½ per cent. on those shares for the year ended March 31, 1889.

Crompton and Co., Limited.—First report of the Directors, presented at the annual general meeting of the shareholders at the City Terminus Hotel, Cannon-street, on Thursday, the 11th inst. The Directors have pleasure in submitting to the shareholders the accompanying first annual statement of accounts and balance-sheet, made up to March 31 last. This account includes a record of the business done during the period of four months prior to the formation of the Company, a period when electrical work generally was not brisk, and when, moreover, the attention of the proprietors was occupied in the negotiations for the formation of the Company. Notwithstanding this drawback, and the fact that the benefit of the increased capital was only beginning to be felt during the financial year comprised in the accounts, it is satisfactory to report that the net profits are in excess of the average of the previous six years, and admit of the payment of dividends both on the preferred and ordinary shares. After payment of the interim dividend in January last, and providing for vendors' interest and other payments shown in the accounts, there remains a surplus of £5,433. 2s. 7d., which the Directors propose to dispose of as follows: 1. To carry to a suspense account a sum of £1,500 as a provision for doubtful debts and contingencies. 2. To place a sum of £568 to a reserve fund for equalising future dividends. 3. To declare a dividend of 7 per cent. per annum on the preference shares. 4. To pay the Managing Directors their fees of £1,000, according to the articles of association. 6. To declare a dividend of 5 per cent. per annum on the ordinary shares. The sum of £4,594. 11s. 6d. has been expended upon enlargement of the works at Chelmsford, and for additions to plant and fixtures. The works are thus rendered much more efficient for economical manufacture, and when the new offices, which are in course of construction, are completed, much time and expense will be saved in the management of the business. Contracts for lighting have been agreed with the Corporations of Folkestone and Chelmsford, and orders for central stations for several provincial towns are practically arranged for. The Company is receiving the benefit of the fresh start which has been made in electric lighting, and the works are consequently busy; there appears, therefore, every reason to anticipate that the present year will be a prosperous one. The business of the Company with the Australian colonies is rapidly increasing, so much so that the Company's agents, Messrs. Harrison and Whiffen, have requested that additional capital may be provided by means of a separate company to which they would themselves largely subscribe. An Australian company has accordingly been registered, and a circular on this subject will shortly be forwarded to the members of this Company. The auditors, Messrs. Duncan Bryce and Company offer themselves for re-election.

PROVISIONAL PATENTS, 1889.

JULY 1.

10593. **An improved galvanometer.** William Harry Grimsby, Tunstall, and Alfred Dobrée, Goldenhill, both in Stoke-on-Trent.
10597. **Improvements in electrical apparatus for lighting gas.** Henry Josiah Griswold, 3, Station-street, Leicester.
10609. **Improved method of automatic electric signalling on railways.** Henry Schultes Schultess-Young, 2, Dr. Johnson's-buildings, Temple.
10638. **Improvements in electro pneumatic organs.** Thomas Casson, 28, Southampton-buildings, London.
10640. **Improvements in electric arc lamps.** Thomas Philip Christopher Crompton and Albert Essinger, 11, Hatton-garden, London.
10641. **Improvements in the construction of underground conduits for electric conductors.** William Ernest Gray, 6, Bream's-buildings.

JULY 2.

10647. **Improvements in the application of primary batteries and electro motors to tricycles and other velocipedes.** John Sherrin and John Vaughan Sherrin, 77, Chancery-lane, London.

10678. **Improvements in electric transmitters for telephonic communications.** Guillaume Arnaud Nussbaum, 29, Ludgate-hill.

10695. **Improvements in electric batteries.** Henry Harris Lake, 45, Southampton-buildings, London. (Charles Albert Hussey and Edwin Henry Brown, United States.)

10696. **Improvements in electric batteries.** Henry Harris Lake, 45, Southampton-buildings, London. (Charles Albert Hussey and Edwin Henry Brown, United States.)

10699. **Apparatus for automatically regulating the potential in the conductors for two or more sets of electrical lamps.** Siemens Brothers and Co., Limited, 28, Southampton-buildings, London. (Siemens and Halske, Germany.)

10708. **Improved automatic electric cut-out.** Stanley Charles Cuthbert Currie, 24, Southampton-buildings, London. (Complete specification.)

10709. **Improvements in insulators for electric batteries.** Stanley Charles Cuthbert Currie, 24, Southampton-buildings, London. (Complete specification.)

JULY 3.

10730. **Improvements in apparatus for electric signalling from or to mining or other cages.** Herbert Cheesman and Reginald Foster Cheesman, Moreliff House, Hartlepool.

10744. **An improved process for the manufacture of filaments for electric incandescence or glow lamps.** Ernest de Pass, 54, Fleet-street, London. (Alexandre de Lodyguine, France.) (Complete specification.)

JULY 4.

10801. **Improvements in electric lamps.** Henry Pieper, 47, Lincoln's-inn-fields, London.

10814. **Improvements relating to lanterns for electric lamps, and to posts for supporting the same, and for similar purposes.** Richard Edward Keen, 45, Southampton-buildings, London. (Complete specification.)

10821. **Improvements in or relating to electrical apparatus partly for curative purposes.** Charles Friederich Aird, 323, High Holborn, Middlesex.

10822. **Improved apparatus for extracting gold and silver from their ores by electrical amalgamation.** George Button and William Edward Wyeth, 28, Southampton-buildings, London.

JULY 5.

10878. **Improvements relating to electric telephones.** Donald Barns Morison, 45, Southampton-buildings, London.

10889. **Improvements in the electrolytic production of hydrochlorite of sodium.** Emile Marie Hippolyte Andreoli, 24, Southampton-buildings, London. (Complete specification.)

JULY 6.

10896. **A new and improved form of support for insulators used for electrical purposes.** Philip Walters, 217, Latimer-road, Notting Hill, Middlesex.

10897. **Improvements in the methods of distributing electricity from central stations.** Thomas Parker and Edmund Scott Gustave Rees, Commercial-road, Wolverhampton.

10933. **Improvements in secondary electric machines.** Michael von Dolivo-Dobrowolsky, and The Company Allgemeine Elektrizitäts-Gesellschaft, 47, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED

1888.

11503. **Electric generators.** Pyke and Barnett. 8d.

11569. **Secondary batteries.** Pieper. 6d.

1889.

135. **Electrically lighting, &c., railway vehicles.** Timmis. 8d.

898. **Fire alarm, &c., telegraph.** Hale and Others. 8d.

7129. **Arc electric lamps.** Howes. 6d.

7526. **Electric arc lamp.** Alcock and Galopin. 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.	Name.	Paid.	Price Wednes- day
12 Feb. 1/2	Anglo-American Brush E.L.	4	3½
12 Feb. 2/0	— fully paid ..	5	4½
14 Nov. 0/4½	Con Telephone & Main ...	1	½
27 July 10/0	India Rubber, G. P. & Tel.	10	19½
..... 2½	House-to-House	4½	4½
30 May 2½%	Oriental Telephone	11	½
.....	London Electric Supply ...	5	3½
.....	Swan United	3½	3½
12 July 12/0	Telegraph Construction ...	12	43
2 July 6/0	— 6%, 1889	100	105
29 Nov. ... 5/0	United Telephone	5	15

NOTES.

Paris.—The Boulevard de Strasbourg at Paris is being lighted by electric light. The underground mains have already been laid by the Société Mancel Deprez, but the lamps are not yet fixed.

The Way it is Worked.—Those who have been watching events for the last few weeks will probably find that one of our electrical contemporaries will now develop quite a strong taste for Sprague motors.

Municipal Control.—The Bureau of Public Lighting, a separate branch under the Department of Public Works, has been established in Philadelphia to control the city lighting, and began operations on July 1.

The Honolulu Cable.—The *Evening Post* of June 17 states that 1,000,000dols. have been subscribed for the proposed cable between Honolulu and San Francisco, and that the work of laying the cable will be commenced within eighteen months.

Volta's House.—The cottage in the village of Lazzatein where Alessandrio Volta spent the summer and autumn months for so many years, pursuing the investigations which resulted in the discovery of the voltaic pile, has been secured as public property.

Dumbarton.—At the meeting of the Town Council last week, it was remitted to a committee to take the necessary steps to prevent an electric company from obtaining powers from the Board of Trade introducing electric light for public and private purposes.

Water and Light.—At Warsaw, Indiana, U.S., a standpipe 20ft. diameter and 150ft. high is needed for the water works. An arc lighting plant is run in connection with the waste water power for street lighting, and it is intended to add an incandescent plant for supply of private houses.

An Electric Railway Trust.—A movement is on foot, it is reported, to consolidate all the electric street railways of America into one association in the interest of electric railway working. The organisation, it is stated, when thoroughly organised, will be one of the strongest in the country.

Electric Tramway in Paris.—An electric tramway is now running between the Avenue du Trocadéro Station of the Circular Railway and the Trocadéro entrance to the Exhibition. This is a great convenience for tourists living near Saint Lazare Station, which is the terminus of the Ceinture Railway.

A Striking Electrolier.—There hangs suspended over the entrance to the Chicago office of the U.S. Express Company a gracefully tapering golden dragon, some 25 feet in length, with a seven-forked tongue darting from its widely-distended jaws, and bearing on each tip a 16-c.p. incandescent lamp.

Westinghouse Consolidation.—It is currently reported, says the *Electrical World*, that there is a movement on foot to consolidate in one the various Westinghouse electrical interests, now so numerous, and to call the new corporation the Westinghouse Electric and Manufacturing Company. Preliminary steps with this end in view have already been taken. The united company will control enormous capital and plant.

Edinburgh.—The Lord Provost's Committee at Edinburgh have decided to recommend the Council to decline

to grant the use of the East Meadows for the proposed electrical exhibition. A suitable site, however, will probably be soon selected. Sir Thomas Clark, Bart., ex-Lord Provost, has accepted the office of chairman of the Executive Committee; and at a meeting held on Wednesday Mr. S. Lee Bapty was unanimously appointed general manager.

Wholesale Damage to Insulators.—In a recent action at Leeds by the postal authorities against some lads who were convicted of throwing stones at the porcelain insulators attached to the telegraph-posts in Gelderd-road, it was stated that no fewer than 530 insulators had been maliciously broken on this line since June, 1887. It seems to point out an incidental advantage in length of life for insulators of a more unobtrusive colour than white porcelain.

Automatic Electric Reading Lamps.—The automatic electric light for railway carriages mentioned in our issue of July 5 is, we are informed, the invention of Messrs. Davies and Tourtel. The manufacturers are Messrs. J. E. Spagnoletti and Crooks, Goldhawk Works, 39B, Goldhawk-road, W. It seems to work remarkably well, and the Great Western Railway are arranging to try it in their night trains, as we believe other railway companies are also doing.

Dover.—At the weekly meeting of the Dover Town Council on Tuesday, the question of electric light was again raised. The town clerk said that in 1882 the Council brought forward a provisional order to hold the ground, but they found that they could not get a provisional order unless they intended to carry out the work. Councillor Brown said that they found that £100,000 would be the cost of carrying out the provisional order and supplying electricity, and therefore it had been abandoned.

New South Wales.—It is said that the agent for the Government of New South Wales made a contract with a company in New York for the supply of pneumatic motors to be used on the street railways of that colony. It seems strange in the present state of progress of electric traction that our colonies should be searching for pneumatic engines while electric motors are to their hand. If it is the case as stated, we think it would be well to have a little light upon the subject and to learn whether the contracts were open.

Coin-Feed Telephone Boxes.—The application of the "drop a penny in the slot" principle has hitherto fallen short of direct business utility to the public; it is, however, now proposed to utilise this method for giving the general public the benefit of the telephone at street corners and railway stations. With a closely-fitting ear-piece and a tube to speak into, the telephone may thus be available for all comers at a penny a time. The old proverb states that "It is the penny-loaf that pays," and the adoption of the idea may prove a financial success for the companies.

Meeting in Paris.—A joint meeting of the Institution of Electrical Engineers and the Société Internationale des Electriciens will be held in Paris on Friday, the 23rd August, to be followed on subsequent days by excursions to places of scientific interest round Paris. As it is necessary in completing the arrangements that the council of the Institution should know how many members will probably attend, an intimation to that effect should be addressed to the Secretary, 4, The Sanctuary, Westminster, on or before next Saturday, the 20th instant. A programme of the meeting will be issued to those members sending in their names as purposing to attend.

Non-Inductive Telephone Wire.—In order to overcome the trouble which the electric car wires cause to telephones, Mr. Henry Campbell, of Waverley, Massachusetts, has introduced a wire for telephone purposes to obviate induction. The wire consists of two strands, one covered with an insulating material, the other a copper wire with the same covering. Both of these wires are twisted loosely together, and at the same time are separated by means of a cord, which is so prepared as not to be affected by the weather. The wire has been recently tested on the same cross arms that carry the current for the street electric cars, and with uniformly satisfactory results.

Utilising the Water Power.—The favourite scheme of imaginative scientists is that of utilising water power running to waste, and there seems nowadays a tendency to turn this idea into practice. Switzerland has not been behindhand in such schemes; and in America, we learn that at Duluth, on the St. Louis, a scheme is being organised to utilise the power of the "Dalles of St. Louis," a few miles from the town. The river here falls in a series of cascades with a total fall of some 500 feet. It is proposed to run all the street cars in Duluth, drive an electric lighting station, and supply power for motors, from a single dam at the cascades, and there is room on the St. Louis for thirty or forty of such dams.

Lighting of the London Bridges.—The London County Council held a meeting on Tuesday last, at which the question of lighting the bridges of London was mentioned. Alderman A. H. Haggis (chairman of the Highways Committee) brought up the report of the committee with a letter from the Board of Trade enclosing copies of provisional orders with regard to the Electric Lighting Acts. The letter stated that the committee were desirous that the public bridges vested in the Council should be included among other places where the electric light could be introduced, but no power was conferred by the order to interfere with any portion of a public bridge other than the roadway over it. The report was agreed to.

Paris Boulevards.—The success of the Thomson-Houston arc lamps on the grand boulevards at Paris has been so great that the Paris Municipal Council are considering the question of lighting the streets round the Hôtel de Ville. The arc lamps on the boulevards certainly are a very brilliant sight, and are neatly and artistically furnished, in true accordance with Parisian procedure. The wires are all underground, and the arc lamps are mounted on tall posts of special design, each planted in a small oasis or islet down the centre of the road, such as are found on some of the crowded street crossings in London. It is proposed to utilise for the new scheme the engines and dynamos which already exist in the cellars of the Hôtel de Ville.

The Incandescent Lamp Patents.—We have received the following notification from Mr. E. Garcke, manager and secretary of the Anglo-American Brush Electric Light Corporation, dated 9th July, 1889: "Dear Sir,—I beg to notify you that, under the arrangement we have come to with the Edison-Swan United Electric Light Company, we discontinue the manufacture of Victoria incandescence lamps in the United Kingdom. With regard to the Victoria incandescence lamps now in use, the arrangement is that our customers shall not be disturbed or prevented from using such lamps, unless the Edison-Swan Company wish to replace them by lamps of their own manufacture, in which case they shall carry out the substitution without charge to our customers."

Dundee and the Electric Light.—At the monthly meeting of the Dundee Police Commission last week it was reported that three companies had intimated their intention to apply to the next session of Parliament for provisional orders to supply the city with the electric light. It was stated that the Gas Commission and the Town Council had already appointed committees to consider the subject. The Gas Commission was the local authority empowered to deal with the matter, but, on the suggestion of Mr. Low, the Police Commission appointed a committee to consider the subject, and if necessary co-operate with the Gas Commission, and report thereon. In answer to a question, the Clerk said that Major Marindin had recommended the Board of Trade not to allow the wires to be carried overhead, but to insist on their being placed underground.

Provisional Orders.—In the House of Commons, on Monday, in reply to a question from Sir G. Campbell as to the electric lighting provisional orders, Sir M. Hicks-Beach said: The draft provisional orders have been in all cases submitted to the local authorities in the metropolis, including the County Council for London. In settling the final terms of those provisional orders I have endeavoured as far as possible to give effect to the wishes of those local authorities, but it has not been possible for me in every case to satisfy every authority as regards every clause of the orders. I may mention as an instance that some of the clauses inserted at the instance of the London County Council are objected to by one or more of the vestries. I have very little doubt that the committee to whom the orders have been referred will be able to deal satisfactorily with the few objections still remaining.

The Provisional Orders for London.—The Select Committee of the House of Commons to whom is referred the Bills for confirming the provisional orders for the electric lighting of the metropolis met again on Wednesday, and confirmed the preambles (which were practically unopposed) of all the remaining orders left for their consideration. The result of this decision is that the whole of the provisional orders which have been granted by the Board of Trade have, without exception, now received the confirmation of the House of Commons, subject to such clauses as the committee may deem it expedient to insert. The orders thus confirmed are the three orders of the Metropolitan Electric Supply Company for the lighting of South, West, and Mid London; the House-to-House Supply order; the Notting Hill, the Kensington and Knightsbridge, the South Kensington, the St. Martin's-in-the-Fields, and the Westminster and London Electric Supply orders.

An Electric Vote Recorder.—The plan of voting in Assemblies by means of the electric current, and thus avoiding the time lost in making divisions, has been before the French Chamber of Deputies, and a report on the subject was presented by M. Montaut last November. In that report the advisability of employing a machine which would indicate not only the total votes "pour" or "contre" a measure—that is to say, the "ayes" and "noes"—but also the number of voluntary abstentions from voting, as distinct from the numbers of absentees. Such an apparatus has been devised by M. Le Goazion. On every desk in front of a member is placed a small box fitted with two handles, which the member works when registering his vote. The right handle registers his "aye," the left his "no," and both moved simultaneously indicate his abstention from voting. The results are printed by means of electromagnets in a receiver, and are visible at a glance.

Provision is made for a member to recall and correct his vote during the time allowed for the purpose.

Annual Excursion.—On Saturday last the *employés* of the Liverpool Electric Supply Company, Limited, in conjunction with those of Messrs. Callender and Co., the contractors for the underground mains, had their annual excursion, their destination being Llandudno. The party had very pleasant walks in the neighbourhood, with rowing and other amusements. They afterwards met at the Westminster Hotel for dinner, and at the conclusion the secretary, Mr. B. H. Collins, proposed a toast to Messrs. Holmes and Vandrey, the managing directors, which was heartily received by the company. He referred to the continued progress of the company's operations, this year forming in reality an epoch in the history of the company, owing to the large number of streets in Liverpool now provided with underground mains from which a supply of electricity is available in the same manner as gas is supplied. The healths of "The Works Manager, Mr. A. Clough," and "The Company's Chief Electrician," were also enthusiastically received. The party returned the same evening after having spent a most enjoyable day.

An Experience in Electrical Execution.—That high-tension currents will not always kill, but will act upon the consciousness in various unknown ways, seems an idea which grows in importance as the attempt to introduce execution by electricity continues to be made. Mr. H. M. Stevens, of Boston, U.S., has just practically been executed, and does not believe electricity can properly execute a criminal. He slipped while examining an electric light plant, threw out his hands, and caught the brushes of a dynamo, receiving the current at 1,500 volts. He was knocked senseless, dropped off by his own weight, and had two doctors at work on his body, which was cold, stiff, and pulseless, and for three hours he remained unconscious. This, he explains now, was because the shock charged him and he was "full of electricity, and insulated." An attendant suggested putting him to earth on damp ground to let the charge "run out." This was done, and Mr. Stevens rapidly recovered and returned to business, though he is still sensitive when thunderstorms are in the air. The idea seems to be that the effect of a shock is an abnormal charging of the cellular parts of the body considered as condensers, and that the effect of a dangerous shock might be counteracted by immediately putting the subject to earth and discharging him.

Initial Phase of Electrolysis.—According to the Chemical Society's *Journal*, M. Piltschikoff finds when a current is passed between similar metallic electrodes immersed in a salt of the same metal, electrolysis takes place whatever the E.M.F. of the current, but if the cathode consists of a more electropositive metal, Lippmann has shown that electrolysis requires a certain minimum E.M.F. With gold and zinc electrodes in zinc sulphate, platinum and silver in silver nitrate or chloride, and platinum and copper in copper sulphate or nitrate, the minimum E.M.F. required is practically the same in all cases, and is 0.036 of the E.M.F. of a Daniell cell. The minimum E.M.F. required to produce visible electrolysis under these conditions is within certain limits independent of the nature of the acid in the salt, the concentration of the solution, and the relative heats of combination of the two metals, and their E.M.F. of contact. It is, however, greatly affected by the physical condition of the

surface of the cathode. The phenomenon is conditioned by the relation between the molecular energy at the surface of the electrodes, or, in other words, by the relation between the energy required to separate n molecules of metal from the surface of the anode and that liberated by the deposition of n molecules on the surface of the cathode. The differences seem to be due to differences between the molecular pressures of the superficial layer of the anode and the superficial layer of the deposit on the cathode, and may alter as the layer of deposited metal on the cathode increases in thickness.

Electrical Communication with Light-Vessels.

As long ago as February 22, 1887, says the *Times*, a committee was appointed by the Board of Trade to enquire into and report on the desirability of electrical communication between light-vessels and the shore, with the special object of facilitating the saving of life at sea; whether the system should be extended to lighthouses, and in other ways; and whether the experience gained by the present cable to the "Sunk" light-vessel has proved of sufficient value to justify the cost. The committee (of which the Earl of Crawford was chairman) have presented their second and final report, which is now published as a Parliamentary paper. Herein they state that though the experiments carried on for the last four or five years show the possibility of establishing electrical communication, they remain of the same opinion as when they made their former report—that the expenditure involved in maintaining electrical communication between the "Sunk" light-ship and the shore is not commensurate with the advantages gained, and they therefore recommend its discontinuance, and that the system should not be extended to lighthouses. They add that it would, as a general rule, be unadvisable to permit lightships which may be electrically connected with the shore to be used also as signal stations for commercial purposes. Sir Edward Birkbeck, M.P., who was on the committee, dissents in one respect. He is strongly of opinion that a much more extended trial of the present electrical communication with the "Sunk" light-ship should be carried out, and that for a further period of not less than five years.

Telephone Vibrations made Visible.—At a recent meeting of the Physical Society, Berlin, Dr. Frohlich made a further communication in connection with his older resultless experiments on the objective demonstration of the vibrations of a telephone disc, in order to describe his new method by which positive results had been obtained. In his earlier experiments he employed manometric flames, and endeavoured to photograph their movements with the help of a rotating mirror; now, however, he attaches a small mirror to the iron plate of the telephone, and from this the light of an electric lamp is reflected on to a polygonal rotating mirror, from which it falls upon a screen. The vibrations of the plate were thus made visible on the screen, and since each side of the polygonal mirror cast its own image, when the mirror was rotated the curves were seen moving over the screen. The more rapidly the mirror was rotated the slower did the curves move over the screen, and when the rotation was as rapid as the vibration of the plate, the curves became stationary and could thus be exactly observed and drawn. These luminous curves could also be photographed. The speaker had employed this method in a series of researches on certain electrical phenomena which might influence the efficiency of the telephone. Thus the action of alternating currents, of self-

induction, of the rise and fall of the current on making and breaking, of the introduction of electromagnets, and of other conditions, were studied by means of the altered mode of vibration of the telephone plate. The speaker had further obtained a graphic record of the vibrations of the telephone plate when vowels and consonants are sung and spoken into it. Many other problems may, by the above method, be brought nearer to their solution.

The Germain Battery.—Methods innumerable have been invented for the purpose of depolarising the fluid in a battery. One of the latest proposals is that of M. P. Germain, chief of the telegraph service at Capdenac, Aveyron, France, who employs the cellulose of the cocoa-nut. It is light, has a cellular texture, does not decay, resists acids, and is very absorbent of liquids and gases. The tissues stick together under pressure, at the same time allowing free passage to the liquid. The actual tissue in a plate thus made is only a small portion of the total volume, and these plates offer a low resistance to the electric current. For these reasons, and also its low price, it has appeared preferable to other absorbents proposed for use in electric batteries. Germain batteries of the type of Leclanché cells have been tested by the French Society for Encouragement of Science. In this battery a solution of chlor-hydrate of ammonia is absorbed by the cellulose of the cocoa-nut. This paste forms a kind of mattress, which is applied upon a bed composed of grains of retort charcoal and of bioxide of manganese. A carbon plate is placed in the centre of these grains and constitutes one pole of the battery. Two plates of zinc superposed are placed upon the cellulose; the exterior plate carrying the second terminal of the battery. The whole is placed in a wood box, and four wedges disposed between the zinc and the cover of the box press the cellulose against the bed of carbon. Experiments in various laboratories have shown that the Germain battery polarises less rapidly than the Leclanché. The E.M.F. of one cell is 1.5 to 1.6 volts, and one of these cells, 7 in. long, 4½ in. wide, and 3½ in. high, has been able to give for some moments a current of two amperes. The battery is thought to present several important advantages for many applications.

Atomic Weight of Zinc.—Dr. J. H. Gladstone, F.R.S., and Walter Hibbert, in a paper contributed to the Chemical Society, observe that when amalgamated zinc is used as anode in a zinc sulphate voltameter, the metal dissolved appears to be free from impurity. This they attribute to the electrochemical relations between zinc and its ordinary impurities, the latter being less readily attacked than the more electropositive metal. Results obtained in different voltameters with the same current show a very close agreement, and the authors therefore determined the atomic weight of zinc by applying Faraday's law of electrolysis. For this purpose a series of copper, silver and zinc voltameters were arranged in a simple circuit, and the quantity of zinc dissolved was compared with the weights of deposited silver and copper. The results of five experiments are given, but as two zinc voltameters were employed in each, the data afford ten comparisons of the equivalents of silver and zinc, and eight comparisons of those of zinc and copper. The mean ratio of the equivalents of silver and zinc is 3.298 ± 0.00008 . Taking the atomic weight of silver as 107.93, this ratio gives 65.44 as the atomic weight of zinc. If silver is taken as 107.66, zinc = 65.29. The copper sulphate voltameter is not so accurate as the silver one, owing to the solvent action of the solution on

copper. But by keeping the density of the current within certain limits, this action can be made extremely small. Still the ratio Zn : Cu given by the experiments (1.0322) is probably rather higher than it ought to be. There is also uncertainty as to the atomic weight of copper, but the authors have used W. N. Shaw's value, 63.33. This gives $63.33 \times 1.0322 = 65.37$ as the atomic weight of zinc. The two comparisons indicate 65.3 as being very near the true value. This is higher than the results obtained in recent years by Marignac, Baubigny, Morse, and Burton, but lower than that given by Reynolds and Ramsay.

Life of Arc Light Carbons.—An interesting thesis on the length of life of arc light carbons is contributed to the organ of the Cornell University by Louis B. Marks, of which the following is an abstract: "Although in all probability a great amount of work has been done upon the subject, the publication of facts concerning the modes of manufacture, the laws of candle-power, life and efficiency of arc light carbons has, until recently, been very limited in extent. A few facts, heretofore unpublished, may throw some light on this important subject. The question has been asked in what manner and to what extent the size of the carbon affects the results in a current of given strength, covering, of course, in the general question of conductivity, the all-important results of light and life. The conclusion is now drawn from a multitude of experiments that with carbons of the same manufacture and type the life of the carbon varies directly with its diameter and inversely with its resistance. Thus the life of a 1 in. Brush carbon having an actual diameter of .986 in. and a resistance of .061 ohm is, according to test, 26.15 hours. According to the law above stated the life of a five-eighths inch Brush carbon having an actual diameter of .618 in. and a resistance of .0735 ohm would be by calculation 13.62 hours. When put to test, this carbon burned 13.64 hours. Many other examples might be given here, but lack of space prevents. In the law stated above it is understood that the relation holds true only when the current and the difference of potential between the terminals of the lamp are kept constant in all cases. Those systems in which a small current and a long arc are used are considered as high-tension systems, and those in which a large current and a short arc are used as low-tension systems. It has been found that, generally speaking, a moulded carbon is superior for high-tension and a forced carbon for low-tension systems. Forced carbons are made by pressing the mass through a die of given size, after the fashion of 'squirting' lead pipe. The following figures speak for themselves: Tests of efficiency—High tension: ½ in. moulded carbon, efficiency 11.71; ½ in. forced carbon, efficiency 8.88. Low tension: ½ in. moulded carbon, efficiency 9.32; ½ in. forced carbon, efficiency 11.05. From the candle-power and efficiency tests of carbons, it has been determined that the efficiency of a copper-plated carbon is exactly the same as that of an unplated carbon of the same diameter, although the life of the former be from 30 to 40 per cent. longer than the latter."

London and the Electric Light.—The following letter, dated 9th inst., has been sent by Mr. Mark H. Judge to the editor of the *Metropolitan*, and is worthy of special attention as regards the necessity for provision of auditing the accounts of electric companies: "Sir,—Four Bills for confirming provisional orders under the Electric Lighting Acts, as introduced by Sir Michael Hicks-Beach, president of the Board of Trade, were read a second time last night.

These Bills give powers to various companies in the following metropolitan districts: Chelsea, St. George's, Hanover-square, St. James's, Westminster, Clerkenwell, St. Martin's, Lambeth, Newington, Southwark, Rotherhithe, Greenwich, Kensington, St. Giles's, Holborn, Strand, and Marylebone. In a recent communication to the Board of Trade on the subject of these orders, the London County Council asked for the transfer to itself of the powers of control and purchase now vested in the local authorities. The Vestry of Paddington thereon passed a series of resolutions taking the strongest exception to this proposed transfer of authority. The resolutions were forwarded to the Board of Trade, and a reply has been received to the effect that these proposals of the County Council cannot be introduced into a provisional order, inasmuch as they involve an alteration of the law, and that therefore those who think the change desirable must bring the matter before Parliament in a Bill to amend the Electric Lighting Acts. Thus for the present the attempt to centralise the management and control of the lighting of the metropolis has failed; but the efforts of the County Council to weaken the control of the local authorities have not been without effect on the provisional orders now before Parliament. For instance, the power is given to the County Council to permit overhead wires in any district, irrespective of the local authority. Overhead wires are so objectionable that there can be no objection to the consent of the County Council being made necessary before such wires are permitted; but surely these wires ought not to be allowed in any district without the consent of the local authority. The model order issued by the Board of Trade did not provide for the protection of the sewers of the local authorities; but I am pleased to see that this omission does not occur in the orders as submitted to Parliament. The provisional orders vest in the County Council the appointment of inspectors to test currents, certify meters, etc. That the County Council should be entrusted with these powers of inspection and supervision will be generally accepted as reasonable and expedient, as coming properly within the functions of the central metropolitan authority, without derogation to the powers, duties, and responsibilities of the local authorities. What appears to me to be the greatest blot on the provisional orders as they now stand, and to which I specially desire to direct attention, is the absence of provisions for an audit of the accounts of the undertakers on behalf of the local authorities. Unless the value of the rights of purchase, which the Electric Lighting Acts give to the local authorities, is to be greatly discounted, to the disadvantage of the ratepayers, it is obvious that an annual audit of the accounts of the undertakers should be made by the local authorities. This is necessary for various reasons; (1) to secure that the accounts are correct in principle and detail; (2) that the provisions with regard to the prices to be charged to consumers are complied with; and (3) to secure that a portion of surplus profits shall be applied in reducing the price to be subsequently charged to consumers. This question of audit alone is of such moment to the ratepayers of the metropolis, that I trust the local authorities, even at this late period of the session, will take such steps as may be necessary to prevent the confirmation of the provisional orders as they now stand."

Railway Signalling.—Some important improvements to the methods of electric signalling and controlling railway trains have been worked out by Mr. Henry J. Peddie, Tynecastle Iron Works, Edinburgh, who has been engaged

on the subject of reducing the risk of collisions for some years. The apparatus proposed is to serve two distinct purposes, the one to automatically sound a whistle on the engine and stop the train should the driver fail to notice the signal is at danger; the other can be used instead, but is worked by the signalman from his box, and has the advantage of giving the signalmen the control of the train at every point along its journey. The first apparatus is styled the detector sound signal and locomotive safety steam cut-off, and consists of two parts, one attached to the sleepers and the other to the locomotive. Opposite the semaphore signal-post a cast-iron shoe is fixed on a sleeper close to the rail. This shoe has two arms pivoted on it, and these are connected to each other and to a balance weight. They are also connected by a wire with the ordinary semaphore. When the latter indicates that the line is clear the two arms are drawn down, so that the apparatus on the locomotive passes clear of them. When the semaphore indicates danger the balance weight throws the arms up into a vertical position, in which they will catch and set in motion an apparatus fixed under the floor of the locomotive. This appliance, again, is so constructed that automatically it shuts off the steam in the engine, sounds the whistle, and applies the air brake to the whole train. Modifications of the arrangement admit of the whistle being sounded without the shutting off of the steam, and, further, of its application to trains which are not supplied with the continuous brake. The second apparatus, termed the railway train electric controller, enables the same actions to be brought about by the signalman from his box, at the same time indicating the point a train has at any time reached. This electric controller involves two sets of apparatus. A battery or other source of electrical supply is placed in the signal-box. From it a conductor is led along the line to the signal-post or to the next station, or any desired length. The conductor is a thin metal rail laid on wood between the usual rails, while one of the ordinary rails will serve as a return circuit. From the same battery wires are led to short conductors placed parallel with each other, but insulated, between the rails, at any desired distance apart. The plates of these conductors form the open poles of the electric circuit. A pendant wheel from the locomotive tender is so placed that it touches the conductors as the engine passes along. In so doing the wheel completes the circuit, an electric bell in the signal-box is rung, and an indicator shows the point the train has reached. To the locomotive itself another pendant wheel is attached. It travels along the long conductor, and from the pendant wheel a wire is carried to an electromagnet placed below an air or steam cylinder. In the event of a train passing a semaphore signal at danger, an intimation of the fact is conveyed to the signalman in the box, who will send a danger signal. The effect of this will be to set in motion apparatus which will shut off the steam in the advancing engine, sound the whistle, and apply the brake to the whole train. In short, the signalman has at all times complete control over a train, and, as a matter of fact, if such a system only could be proved sufficiently trustworthy, the working of the mechanical semaphores would hardly appear necessary at all, and all signalling could be done on the engine. Various modifications and simplifications are suggested by the patentee for different cases, and a similar apparatus is applicable to mines.

ELECTROLYSIS OF BISMUTH SALTS.

BY ALEXANDER WATT.

(Continued from page 27.)

14. *Basic Nitrate of Bismuth in Acetic Acid.*—In this experiment a quantity of well-washed basic nitrate of bismuth was digested in acetic acid, and the mixture heated to the boiling point, when the basic salt rapidly dissolved. Fresh additions of the bismuth salt were made until the acid became saturated. The resulting solution was then freely diluted with water, and electrolysed with the current from a single small Daniell cell, when a bright film of bismuth at once formed upon a brass cathode. After a few minutes' immersion, however, the deposit turned black from the formation of non-reguline metal. The solution was then still further diluted, and a fresh plate immersed, which slowly received a coating of bismuth, but, as before, the deposit turned black after the plate had been in the bath about half a minute. It was next determined to neutralise the solution—which was in an acid condition—with ammonia, and when this had been effected the black or spongy metal ceased to appear, and the film continued bright during a long immersion. It would thus appear probable that a carefully-prepared solution of the composition given might be available as a depositing-bath.

15. *Chlorides of Bismuth and Sodium.*—A solution of chloride of bismuth was added to one of chloride of sodium, and the liquid afterwards diluted with water. With the current from one cell and very small anode surface, a bright deposit of bismuth was quickly obtained upon a brass plate, but immediately after this slight film had formed the surface of the plate suddenly turned a deep black, owing to the metal assuming the non-reguline character. The bath was next diluted with successive doses of water, a freshly-prepared plate being immersed after each addition, in the hope that a weaker solution would induce the metal to deposit in a bright reguline condition. Such was not the case, however, for even when the solution had become exceedingly weak, the deposit, after a slight film had formed on the receiving plate, invariably assumed a black colour after a few moments' immersion of the plate.

16. *Citrate of Bismuth.*—A solution was prepared by digesting hydrated oxide of bismuth in a boiling solution of citric acid. When cold, the liquid was electrolysed with the current from two Daniells, when a bright film of bismuth slowly formed upon a brass cathode, and there was no appearance of black spongy metal.

17. *Citrate and Sulphate of Bismuth.*—The aim of this experiment was to see if an addition of the organic acid salt would prevent the formation of black non-reguline metal, and to a certain extent this really proved to be the case, for the deposits not only became brighter than those obtained from the plain sulphate solution, but the tendency to blackening of the film was considerably diminished. A solution of citrate of ammonia was now added to the bath, which still further improved the character of the deposit, which, though somewhat slow in forming, was perfectly reguline. By increasing the anode surface the metal deposited at a very fair rate of speed.

18. *Citrates of Bismuth and Ammonia.*—A strong solution of citrate of bismuth was added to one of citrate of ammonia, and the mixture, after being moderately diluted with water, was electrolysed with the current from two small Daniells in series, when a bright film of bismuth slowly deposited upon a brass plate, and there was no appearance of black spongy metal.

19. *Aceto-Nitrate of Bismuth.*—In this experiment the object was to obtain crystals of metallic bismuth, in which I had only been partially successful when employing a solution of the simple nitrate. As it is not possible to dissolve crystals of nitrate of bismuth in water, owing to the decomposition of the liquid which takes place, with the formation of a basic salt, I determined to see whether the nitrate salt would dissolve in commercial acetic acid, and yield a clear solution. On adding acetic acid to moist crystals of the nitrate, they at first assumed an opaque white appearance—doubtless due to the water contained in the acetic acid (which only contained 15 per cent. of real

acid)—but when the mixture was well stirred with a glass rod, the white salt gradually disappeared, being dissolved by the acetic acid, and a clear solution was soon obtained. This solution of aceto-nitrate of bismuth was then poured on to a glass plate, around the edges of which I had previously built up a wall of paraffin wax, to enable the liquid to remain on the glass without overflowing. A bismuth anode, connected to a single-cell Daniell, was then placed on the glass plate in a vertical position, and a copper wire, as a cathode, was fixed at a distance of about one-fourth of an inch from the anode. In about half a minute or so, crystals of bismuth formed upon the end of the wire, and gradually extended towards the positive electrode, which was drawn away from the wire cathode, little by little, as the crystals advanced toward the anode, until the crystals had extended to the length of about an inch and a half, when the electrodes were carefully removed, and the solution cautiously poured off the plate. The washing of the crystals was the next consideration, and this was first effected with acetic acid alone, which removed a greater proportion of the aceto-nitrate, when, the same acid, diluted with successive and gradually increasing small quantities of water, was used, which method of washing the crystals was tolerably successful, but, unfortunately, from the extremely fragile nature of the crystalline group, it became broken in the progress of the washing, and I was unable to accomplish what I had desired—namely, to obtain photographic prints from them as I had successfully done both with tin and lead crystals on former occasions. I hope, however, to be more successful at another time. It should be mentioned that the bismuth crystals were of a tree-like form, the ramifications extending forward, and laterally, presenting the appearance of a leafless tree with numerous branches.

20. *Iodide of Bismuth in Caustic Potassa.*—A solution of nitrate of bismuth was precipitated by one of iodide of potassium, and the orange-yellow precipitate was then well washed, and dissolved in a strong solution of caustic potash, forming a yellow solution. This liquid was then moderately diluted with water, and electrolysed with the current from three Daniells in series, but only a slight film of metal deposited on a brass cathode, while the evolution of hydrogen was considerable, and a yellow salt, probably a subiodide, formed on the anode.

21. *Nitrates of Bismuth and Ammonia.*—To a solution of the basic nitrate—obtained by adding water to the salt after frequent washings with water—was added a solution of nitrate of ammonia. With the current from one cell, a very quick deposit of bismuth was obtained upon a brass plate, to which it very firmly adhered. After a few minutes, however, the film became dull, and assumed a grey colour.

22. *Oxalate of Bismuth.*—A quantity of moist carbonate of bismuth was digested in a boiling solution of oxalic acid, in which only a small proportion of the carbonate dissolved. The solution, with the current from two cells, yielded a very trifling deposit of bismuth on a brass plate.

23. *Ferrocyanide of Bismuth in Cyanide of Potassium.*—A solution of bismuth sulphate was precipitated by one of ferrocyanide of potassium, and the resulting yellowish precipitate, after being well washed, was dissolved in a strong solution of cyanide of potassium, which freely dissolved it. With the current from two cells a bright reguline film of bismuth slowly formed on a brass plate, and it was noticed that the anode surface above the liquid assumed an iridescent appearance, probably owing to the action of cyanogen vapour.

(To be continued.)

DIAMAGNETISM.

BY S. E. PHILLIPS.

A new edition of Tyndall's "Diamagnetism" may fitly give occasion for some new remarks in support of the contrary views so ably maintained by Faraday. It is now some 30 years since this subject was investigated by the leading physicists of that day; and were it not that both Faraday and Tyndall were men of high intellectual abilities,

and not less of moral attainments, the quarrel might have been more bitter than it was.

After 30 years of further research and progress, I think it is due to the subject, and no disparagement to Faraday, that a brief restatement of the phenomena should be initiated as from a modern and independent point of view.

It has appeared to me anomalous beyond measure that, while we freely admit relative conductivities for light, heat, sound, and electricity, that magnetism or polar-force should be exempt from such a common necessity. A persistence in this curious mistake has called forth no end of complex and contradictory hypotheses to explain polarity or "opposite, opposite polarity," phenomena which are plain and simple beyond measure as due to relative conductivities.

A balloon rises in the air when its bulk is specifically lighter than its medium, or sinks from an opposite relativity when its bulk is heavier than the surrounding air; but we do not require any inversion of the lines of gravitating force in the two cases.

There is no polar attraction in one case, or inversion of polarity in the other case, causing repulsion.

Precisely thus it is with a log of wood, which is either heavier than an equal bulk of water when it sinks, or if it be specifically lighter, then it swims. Precisely thus it is with diamagnetism—a word unfortunately coined before the simple facts were clearly apprehended. To suppose that we have two forces—one of magnetism and the other of diamagnetism—is intensely absurd as compared with the previous cases of gravitation. The antithesis of strength and weakness we may have in both phenomena, but no antithesis of opposite polarities.

So resolutely clear on this head was Faraday, that he devised a most elaborate series of experiments to demonstrate the simple truth; and if he has been overruled by the ingenuity and by the experimental and mathematical attainments of his learned compeers, yet the time must come when his ardent and loving labours will be more generally appreciated. He arranged a liquid field of force between two powerful magnetic poles; and suspended therein small tubes of iron solution. It is thus easy to foresee whether these liquid bars should behave magnetically or diamagnetically. If the iron solution of the surrounding medium be weaker or less conductive than that of the tube, the lines of force would be relatively stronger in the tube, which would set axially, or in the line of the poles, and behave as a magnet; but if the surrounding medium be stronger than that in the tube, the effect must be to make the bar magnetically lighter, to push it out of the lines of strongest force, and to set transversely or to behave as a diamagnet.

This may, perhaps, suffice for a brief glance at the character of his research; but for the great skill and ingenuity in devising endless forms of experiment, all tending to the same end, we must recommend a perusal of his research in his own carefully studied words. The Tyndall term "magnetic weight" applies better to the experiments on attraction and repulsion before the radiating lines proceeding from a single pole. In this case Faraday avoided the complication of shape, and a central suspension, working with spheres of varied conductivity.

He represents a magnet and a diamagnet, or in other and better words, a good conducting sphere and a bad one.



FIG. 1.

One is a better conductor of the lines of force than the medium. It is magnetically heavier; in it the lines of force are condensed, and such a body tends more and more to the pole: it sinks, whereas the other being magnetically lighter rises, or is apparently repelled. The fact being

that the lines of force are condensed in the medium in the ratio that they are diminished or opened out in the sphere.

Since Faraday's time, we have now discovered that what we find in gravitation and magnetism is precisely evinced in electricity. In a battery, during electrolysis, we have not a field of lines of static force, but lines of action, or atomic interchange; and if we suspend therein a small bar of copper or of any material which is a better conductor of the electrolytic action than the fluid medium, it acts like a magnet, its long diameter is directed axially or from end to end: it takes a position in the strongest lines of force or action; whereas if the bar be of wood, or a worse conductor than the medium, then it acts as a diamagnet (so called); it is pushed into the lines of weakest force or action, and therefore sets transversely.

We now essay to examine and refute the chief argument of Tyndall in favour of what he then called the "opposite, opposite polarity" of bismuth.

Extraordinary as this may appear in sight of the Faraday survey of wide facts, yet, nevertheless, it has been upheld by some of our highest and best physicists, and vast memoirs of mathematical ability have been employed to illustrate and support the contention.

Of the wanton kind of assumption and hypothesis inherent in such speculations much may be said, but at present we confine ourselves to the notable experiment of Tyndall, by which he deceived both himself and his audience before the British Association.

He first of all provides a coil of wire, and says nothing of the initial stage of proceeding, but it is our aim to make clear every step of the process.

Sending a positive-current of electricity in a right-handed spiral upwards, the effect is plain—viz., that we have a symmetrical field of force in the air medium within the coil, by which N polarity is induced at the top end, and S polarity at the bottom, with a concentration of the lines of force in the middle. Now, let the coil be placed horizontal, and a bar of iron suspended, through an opening in the coil, and we know that its magnetic conductivity being so enormously superior to that of air, it would take an axial position in the central lines of strongest force, and be in a position of stable equilibrium; or, replacing the iron bar by one of bismuth, we know that its magnetic conductivity is weaker than that of air, hence would be its tendency to be pushed aside, or by a necessity of its central suspension, to assume a transversal position, which it would follow until arrested by the side of the coil.

This being clearly understood, we can proceed to the next step, by which he seeks to produce an asymmetrical, or one-sided field of force, where A becomes B.



FIG. 2.

This is produced by external coils angularly presented to deflect the lines of force from a central to a side position. We now suspend an iron bar in the coil, and it is childishly easy to foresee what would be the effect; it would set from N to S, or in the lines of strongest force.

We now replace it by a bar of bismuth, whose behaviour is strictly and exactly as it was before, and its natural or transverse tendency is arrested by the edge of the coil. "And lo!" says the lecturer, "you see that if iron is attracted to an S pole, bismuth, under the same conditions, is attracted to an N pole, by virtue of its opposite, opposite polarity."

Now, had there been one tittle of proof that it was so attracted, and that it was in a position of equilibrium, the

experiment might have been valid. However it was, that Faraday did not see through this delusion and mistake is amazingly unaccountable, because any tyro of this date must know that if we repeat the experiment with a wider coil, and so arrange the external magnets as to bring their conjoint influence within the coil limits, we should have something like the following rough diagram of the forces involved:



FIG. 3.

Now, the iron by its momentum might strike the edge of the coil, but its strong vibrations would end in a stable equilibrium from N to S, midway between the centre and the edge of the coil; and if bismuth possessed an "opposite opposite" polarity, it would similarly find a stable equilibrium, pointing to the external N; but we know, as certainly as we know that 2+2 make 4, that it would do nothing of the kind; there would be no strength in its movement, and only a weak tendency to set transversally; it would indifferently pass N and be arrested by the edge of the coil, and so far justify Faraday's resolute contention in regard to this and all other experiments: "I see nothing in all these things beyond what we have seen all along—viz., that strong magnets tend to the lines of strongest force, while diamagnets (weak magnets) tend to place themselves in the lines of weakest force."

We shall next see that by a different arrangement, with a wider coil and a shorter bismuth bar, Tyndall has himself demonstrated the Faraday contention to the fullest degree, but with an unfortunate attempt to make it appear otherwise.

(To be continued.)

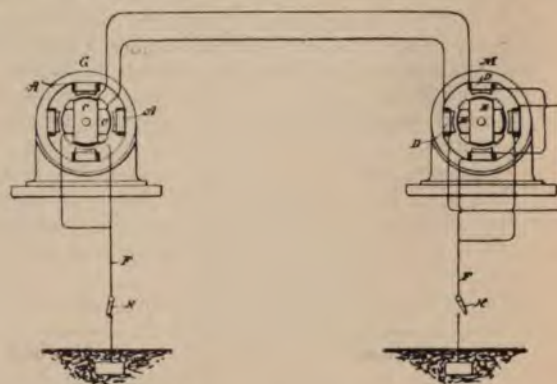
TESLA SELF-STARTING ALTERNATING MOTOR SYSTEM.

As is well known, certain forms of alternating-current machines have the property, when connected in circuit with an alternating-current generator, of running as a motor in synchronism therewith; but, while the alternating current will run the motor after it has attained a rate of speed synchronous with that of the generator, it will not start it; hence, where these "synchronising motors," as they are termed, have been run, some means have been employed to bring the motors up to synchronism with the generator before the alternating current of the generator is applied to drive them. In some instances mechanical appliances have been utilised for this purpose. In others special forms of motor have been constructed.

With the object of affecting the starting of the alternating motor and bringing it to synchronism without external aid, Mr. Nikola Tesla has devised a simple system, in which he employs an earth return during the period of starting only. For this purpose he constructs a generator with two coils or sets of coils, and a motor with corresponding energising coils or sets of coils. By means of two line-wires, one terminal of each generator-coil is connected to one terminal of its corresponding motor-coil while the opposite terminals of the generator-coils are joined together, and likewise those of the motor.

To start the motor, an electrical connection is temporarily established between the points of connection between the coils in the generator and those in the motor, so that the system becomes an ordinary double-circuit system.

When by this plan of connection the motor has attained the desired speed, the earth connection is severed, by which means the system becomes an ordinary single-circuit synchronising system. The accompanying diagram shows the manner in which this is accomplished, G representing an ordinary alternating-current generator having four field-poles, A, magnetised by a continuous current, and an armature wound with two coils, C, connected together in series.



M represents an alternating-current motor with, say, four poles, D, the coils on which are connected in pairs, and the pairs connected in series. The motor armature should have polar projections and closed coils, E.

From the common joint or union between the two coils of both the generator and motor an earth connection, F, is established, while the terminals or ends of the coils which they form are connected to the line-conductors.

Assuming that the motor is a synchronising motor, or one that has the capability of running in synchronism with the generators, but not of starting, it may be started by the above-described plan by closing the ground connection from both generator and motor. The system thus becomes one with a two-circuit generator and motor, the ground forming a common return for the currents in the two-line wires. When by this arrangement of circuits the motor is brought to speed, the ground connection is broken between the generator or motor, or both, and ground switches, K K, being employed for this purpose. The motor then runs as a synchronising motor.—*Electrical World*.

THE BOARD OF TRADE.

The following letter has been sent to the Board of Trade by the secretary of Callender's Bitumen Company, directing attention to the results which will arise from the suggested rules:

"On behalf of Callender's Bitumen Telegraph and Waterproof Company, Limited, of which I am the secretary, I have the honour of laying before you the views of my company with regard specially to rule 9 of the regulations of the Board of Trade in respect of aerial wires, which have recently been formulated.

"My company feel that in its present form rule 9 will not only be exceedingly injurious to important trades now carried on in this country, but that it will be either impracticable or very difficult of application.

"My company have for many years been the manufacturers of an insulating material of exceedingly high quality, produced chiefly from the vulcanisation of refined natural bitumen from Trinidad.

"This composition, which is well known as Callender's insulating material, has acquired a very wide reputation by reason of its uniform excellence, its high insulating power, and its capacity for resisting change under the influence of atmospheric condition of moisture, etc. This last most valuable quality is mainly due to the exceptional stability of bitumen. Notwithstanding the excellence of its quality, it can be produced at a very reasonable price.

"Under the circumstances this insulating material is admirably suited for all descriptions of overhead work, and a considerable business in connection therewith was anticipated so soon as the Board of Trade should insist on electric light wires being properly insulated. But in the form

in which the rules stand, not only my company but all other firms that manufacture high-class insulating substances other than indiarubber would be placed at a great disadvantage, and we have no doubt that the practical results of the rules in their present shape will be to deprive us, and them, of a most important branch of our business, and to induce the public to use inferior insulation instead of that which they would probably use but for the interference with trade due to these rules.

"Before dealing with the case of my company, which is only typical of the whole class of manufacturers of high-class insulating materials in which rubber is not used, I am desired by my company to point out that the rules as they at present stand are open to the gravest of objections of another kind. The words of the 9th rule are as follows: 'High pressure aerial conductors must be continuously insulated with indiarubber or other material equally durable and efficient under the circumstances in which it is used,' etc.

"If by indiarubber is meant pure indiarubber, the rule is simply impracticable, for pure indiarubber would neither be durable nor efficient under the circumstances. It would perish with the weather, and would be a very unsatisfactory covering for the wire. If, on the other hand, we are not to understand indiarubber as meaning pure indiarubber, but indiarubber mixed with foreign substances, there is no limitation or restriction as to the substances which may be incorporated with it, and the consequences will be that materials which are sold as rubber, but in reality contain but a small proportion of that substance, will be in large demand for this purpose. Such compositions would be neither efficient nor durable, and would certainly not compare in either of these respects with many materials which are not rubber at all, and make no pretence of being so.

"My company have no doubt that there was not any intention on the part of the Board of Trade to interfere with the manufacture of high-class insulating materials, and no doubt it is thought that the words 'or other material equally durable and efficient' would prevent any such interference, but my company can assure the Board of Trade that in practice such will not be the case. The public, seeing that one substance is specially mentioned as satisfactory to the Board of Trade, will at once choose that by preference, in the belief that by so doing they avoid all questions being raised as to the suitability of the insulator, and that if they take any other insulator they impose upon themselves the burden of proving that it is as 'durable and efficient' as indiarubber. This will render it exceedingly difficult to persuade persons interested to use any other insulator, and this difficulty will be very greatly increased by the impossibility of ascertaining what is meant by 'indiarubber,' or what standard of purity and durability it is supposed to attain to. This opinion is not merely a speculative one on the part of my company, for they have reason to believe that a large order has already passed them (which they would otherwise have obtained) solely because the parties preferred to take the insulator mentioned in the rules, and so avoid all question as to its being a proper insulator.

"I am desired to point out that the mention of indiarubber in clause 9 is the only instance in the rules of any specific material being referred to, and that, apart from the extreme unsuitability of the term 'indiarubber' as a standard for efficiency and durability, there is no need to refer to any specific substance as a standard, as clauses 10 and 11 by themselves would sufficiently provide for the public safety. If it is thought that any reference should be made to the kind of material to be used, the provision might stand that the conductor should be insulated with a durable and efficient material of a kind to be approved of by the Board of Trade. My company and other manufacturers of insulating material, or of covered cables, would then have the opportunity of submitting to the Board of Trade samples of the material used by them for approval, and their specifications could then provide that the insulating material used should not be inferior to the sample so approved of. By these simple means the Board of Trade would be able to insist on high-class insulation without prejudicing any branch of the trade, or tending to discourage future improvements in other substances as insulators.

"In conclusion, my company wish it most clearly to be understood that in thus urging the Board of Trade for an alteration of the rules they are not seeking in any way to lower the standard of insulation to be required by those rules, or to facilitate the use of inferior insulating materials. On the contrary, they are satisfied that their material will bear favourable comparison with any dielectric under circumstances which will thoroughly test efficiency and durability. Nor do they object to the imposition of any tests for efficiency or durability which will apply to all insulating materials alike.

"But they feel strongly that as the rules at present stand they will put a premium on the use of compounds which pass by the name of indiarubber as against superior materials of a different kind."

CORRESPONDENCE.

NON-MAGNETIC ALLOY.

TO THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—I have recently been making some experiments on the magnetic properties of an alloy of iron and nickel. A statement of the result may be of interest to some of your readers. I am informed by Mr. Riley, of the Steel Company of Scotland, who gave me the sample I have used, that it contains 24.5 per cent. of nickel and 0.85 per cent. of manganese. It proves to be almost non-magnetic, its permeability being only 1.4, much the same as that of manganese steel. On heating a block of the metal to a high temperature and allowing it to cool and noting the temperatures at successive times, it is found that the curve expressing the relation between temperature and time exhibits no disturbance such as I have observed with wrought iron and steel. The non-magnetic properties of this material are very remarkable, both iron and nickel being strongly magnetic.—Yours, etc.,

J. HOPKINSON.

5, Victoria-street, S.W., July 15, 1889.

TATHAM'S CABLES.

TO THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—I notice in last week's issue a note regarding these cables as manufactured by Fowler, of Leeds. Having had some experience of these cables in practice, I found one or two points to which attention might be directed. These cables seem to be in common with most other lead-sheathed mains in that they greatly deteriorate with coiling and uncoiling. The somewhat resinous character of the insulation renders the life of the cable somewhat uncertain where it has been much handled before laying down. I have only been interested in these cables where they have been carrying the usual lamp pressure of 110 volts, and from the extremely thin layer of dielectric employed can hardly see how they will stand such a pressure as 1,000 volts for any length of time if laid underground directly in contact with the earth. The thickness of the insulating material in a $\frac{7}{32}$ cable is about $\frac{1}{16}$ in. and with a $\frac{37}{16}$, just over $\frac{1}{8}$ in. This, coupled with the fact that the larger of these is subjected, in coiling and uncoiling, to a much severer stress renders the insulation resistance of the larger sizes very much less than that of the smaller. Why not have a rather more proportionate thickness of dielectric to the leakage area of the conductor? These cables are used at Crieff to carry the current from the generating station to the distributing centres, and with the pressures used these have given every satisfaction.

London, July 17, 1889.

CHARLES H. YEAMAN.

Railway Working by Electricity.—The Elevated Railroad of New York has been experimenting for some time with the Daft electric locomotive. The Elevated Railroad of Kansas has now decided to run one of its branches with electricity as the motive-power. The days are evidently at hand for the general working of heavy railways by electricity.

THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence ; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices :
139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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Specimen copies of the paper will be sent on request.

AGREEMENT.

Perhaps the most important step ever taken in the electric lighting industry is that promulgated this week from two centres—the Edison-Swan Company and the "Brush" Company—relating to their agreement to forego further litigation. The wisdom of this step is clear to everyone, except the lawyers. That this action accords with the opinion we have again and again expressed conveys to us some slight satisfaction that, though late, the opinion has been found to be right and best for all parties from a commercial point of view, and we hasten to add that, so far as we can see, it can be considered from no other standpoint. Hitherto, shareholders have had no great returns from industrial operations, though a good deal of money has been made and lost by financial operations. The continued prosperity of the industry, however, depends not upon profits made by buying and selling shares, but by profits made upon work done, whether that work be manufacturing or supplying. It is difficult to say with certainty, without examination of the books of every company and every inventor, but, broadly speaking, we may venture to say that "lawyers" and "scientific witnesses" have benefitted as yet to a greater extent pecuniarily than have shareholders. Indeed the wonder of the age, and principally introduced by electrical litigation, is the "scientific witness." He is, moreover, a very costly even if he is an amusing and sometimes an instructive creation. Better write his epitaph than employ him, though during the era of rampant litigation he may be said to have been a costly necessity. We suggest the epitaph, "Here lies the fourth degree of comparison."

Resuming, however, our subject, it is evident that in the agreement arrived at there is both giving and taking on either side. The Edison-Swan Company's report dismisses the subject in the following sentences: "The appeal of the company from the decision of Mr. Justice Kay was heard before Lord Justices Cotton, Lindley, and Bowen, who reversed Mr. Justice Kay's judgment, and decided that Mr. Edison's patent, 10th November, 1879, was valid. The Brush Company gave notice of their intention of appealing to the House of Lords, but a settlement has been arrived at by which the case will not be carried to the House of Lords. The Brush Company gave up manufacturing incandescent lamps, and they pay the taxed costs of the action."

The Brush Company, however, gives a further insight into the nature of the agreement, as will be seen from the following extract from their report: "The directors take this opportunity of announcing the settlement of the litigation with the Edison-Swan United Electric Light Company in regard to incandescence lamp patents. Under the arrangement come to, the Edison-Swan Company accept a

license to use the Lane Fox and other incandescence lamp patents held by the corporation, and they pay the corporation a royalty upon the basis of the number of lamps made, but subject to a maximum payment per annum. The corporation, on the other hand, give up the manufacture of incandescence lamps, and agree to buy from the Edison-Swan Company on the most favoured terms to dealers, until the expiry of the Edison patent. The Edison-Swan Company waive all claim to damages, and it will be remembered that in regard to the Cheesbrough patent, the decision of Mr. Justice Kay was against the corporation and no appeal was entered, but the corporation agree to pay the Edison-Swan Company's taxed costs. The arrangement, which applies only to the United Kingdom, fully protects the corporation's customers, who will not be subjected to any inconvenience or expense."

Coming as a corollary to this agreement, the reports of both companies contain information of the highest importance. Taking the "Edison-Swan" first, the directors have to be congratulated upon having come to the end of the long lane, and having the wherewith to pay what may under the circumstances be considered to be a substantial dividend. We know shareholders who in the earliest days of the Swan Company *invested*—the word is italicised and used in contradistinction to speculated with—all their available capital, and from that time to this have patiently awaited the action of the directors in pulling the company through its difficulties and landing it upon the first stage of prosperity. The real investors could not sell their shares during the long period of depression, and we must therefore congratulate them as well as the directors upon the present position of the company. Opinions may differ upon the policy of giving up installation work. We think it was the right one, and we doubt very much if the right policy of the manufacturer is not to be purely and simply a manufacturer. This may not be possible in the earlier stages of an industry, but as time goes on the matter should be carefully considered. At any rate the company under immediate consideration has restricted its operations to manufacture incandescent lamps first, accessories in using these afterwards. The demand in both directions should be enormous and quite sufficient to employ all the energies of directors and management. Make the lamps as good as possible, cheapen them as much as possible, consult the whims and wishes of clients, and by the time patents run out the position of the company will be unassailable.

With regard to the Brush Company, its record is different. Its shareholders have had some return, and it has through the whole time of depression shown a bold front, done good work, and to an enormous extent assisted in keeping the whole

industry from falling to pieces. Saying that sufficiently indicates our views of the management. Now the company is to be reorganised, and we have not the slightest doubt as to the wisdom of the movement. The absorption or amalgamation with the Falcon Works indicates that more attention will be paid to electric traction and the distribution of power. There is a greater field for development in these directions than even the most sanguine imagine. Our advocacy of this policy has been condemned as premature. It is said the public comprehend, and will avail themselves of the distribution of light, and that the distribution of power will naturally follow. That may be perfectly true, and yet to restrict designs of central stations to mere lighting is absolutely suicidal. There is no need to have separate installations for tram lines if electric traction is desired and direct driving is required. The central station should supply the power. But this is digressing into another subject. The other amalgamation is with the Australasian Company, and indicates a determination to push the colonial business with vigour.

The freedom from weighty litigation will relieve both these large companies from an incubus which has long occupied the attention that would have been more profitable if given to purely business concerns, and whether one company feels it has got more than it expected or not, there is no shadow of a doubt but that the agreement will prove beneficial to both parties.

NOTES ON ELECTRIC LIGHTING.*

BY E. I. SILCOCK, A.M.I.C.E., A.I.E.E., BOROUGH ENGINEER, KING'S LYNN.

(Concluded from page 38.)

ACCUMULATORS.

The principle of all accumulators is that a current is run through a battery composed of lead plates in an acid solution, when oxide of lead is transferred from the positive plates to the negative, making them at a higher potential than the positive plates. We have then mechanical energy transformed into electrical energy, which in its turn is transformed into chemical energy, in which form it can be stored and reproduced when required in the form of electrical energy.

This double transformation from electrical energy to chemical and from chemical to electrical causes a certain amount of loss, and probably it may be stated, without being wide of the mark, that on an average 30 per cent. of the energy will be lost, or, in other words, that the efficiency of secondary batteries, as a rule, does not exceed 70 per cent.; this loss, combined with their large cost and the trouble which they occasion, does much to prevent the general adoption of secondary batteries, but they offer great advantages in reducing the number of hours a dynamo has to work at small loads, and in reducing the size of the dynamos and engines. The light from an accumulator is absolutely steady, and consequently lamps have an increased length of life when run from them.

In cases where a power is available during certain hours of the day, or where a small water power is constantly available, secondary batteries can be used with advantage, as it is then possible to utilise at night the power which

* A paper read at the Annual Congress of the Association of Municipal and Sanitary Engineers and Surveyors, Portsmouth, 4th, 5th, and 6th July, 1889.

would otherwise be lost, and they form a great feature in one system of central lighting. Secondary batteries should be very carefully put up, and means adopted to prevent creeping of the acid, which causes leakage.

CENTRAL LIGHTING.

The central lighting of towns may be effected in one of three ways, which may be briefly described as follows:

1. *Direct Supply.*—This system consists of laying down mains (which should be on the three-wire system) from a central station and supplying each house direct with the current. The potential in such a case cannot well exceed 200 volts, and the large cost of the distributing mains makes it practical only for supplying districts within a radius of half a mile from the generating station. This system is adopted by the St. James and Pall Mall company, and the Bradford Corporation.

2. *Transformer System.*—By this system an alternating current is generated at a central station, and conveyed at a high potential varying from 2,000 to 10,000 volts to transformers at various points in the districts to be supplied. The transformers reduce the E.M.F. to 100 volt, and the current is proportionally increased; the current is then distributed to the houses as in the first method. This system is adopted by the London Company, the Metropolitan Company, the House-to-House Company, the Eastbourne Company, and others.

3. *The Accumulator System.*—By this system a continuous current at high potential, of from 1,000 to 2,000 volts, is generated at a central station, and conveyed to distributing stations, where it is used to charge accumulators. The current is then distributed from these accumulator stations at about 100 volts. This system is used by the Chelsea Company and the Kensington and Knightsbridge Companies, and will be used by the Notting Hill and Westminster Companies. The relative merits of these three systems are not finally settled, but it may be said that the direct supply system is practically limited to small towns, or to the more densely-populated parts of large towns. For the supply of large towns from one station, or for sparsely-populated districts, either the transformer or accumulator systems must be adopted.

The arguments for and against these latter systems are very concisely summed up by Major Cardew, in the report of Major Marindin to the Board of Trade, from which the following is extracted:

"The transformer system carries the high pressure up to the houses. The distributing mains, therefore, are of small size. A large district can be served from one station, and the regulation of pressure in the distributing mains can be very good. There should be no great difficulty in maintaining a standard pressure within a variation of 2 per cent. The pressure in the houses may be different in different cases, according to the needs or fancy of the consumer. It is also a simple system to work, and the dynamos are simple, and can be made in easily-replaceable parts. On the other hand, the high pressure necessitates great care and expense in insulation; the conveying of this high pressure to, at any rate, one point on the consumer's premises, and the risk of a contact between this circuit and the low-pressure circuit inside the house, involves some risk to life, although it may be reduced to a minimum by proper regulations and precautions; the main cannot be handled or connections made when the pressure is on; the regulation in the houses is not so good as in the mains, as the transformers act as a considerable added resistance, and cause an increased variation of pressure in the power as compared with that in the mains; the system cannot at present be efficiently utilised for motive power, or for electric deposition or other chemical uses, such as charging accumulators; and it is very doubtful whether a practically successful alternating motor is likely to be brought out; the system depends entirely on running machinery and engines, and dynamos have to be kept in motion throughout the 24 hours; the general efficiency must be low when the supply is near its minimum, a condition which, so long as it is utilised for lighting alone, obtains during about 18 hours of every day on the average, and a serious accident in the generating station might stop the supply for a considerable time. Alternating machines cannot be so readily connected

together to run in parallel circuit as continuous-current machines. The measurement of alternating current, pressure, and power also offers considerable difficulty, and the available instruments and methods are far more restricted in number than is the case with the corresponding quantities in continuous supply.

"The Chelsea system has the advantage of high pressure between the generating and distributing stations, without its being brought into the consumer's premises, and the distributing stations may be so numerous that each one serves only a small district, and in this way the size of distributing mains may be kept down. The supply from batteries has these enormous advantages: that in the event of a total breakdown at the generating station supply can still be maintained for some hours; that it is not necessary to keep the machinery at the generating station in motion throughout the whole 24 hours, and that the batteries provide a supply for the long hours when very little is required; the system has the advantages of continuous currents—viz., applicability to the supply of motive power, and other uses besides light and heat, and greater ease of measurement. The regulation, with small areas supplied from each sub-station, should be very good, and there is no doubt that a battery current is less destructive to lamps than one supplied from dynamos, whether alternating or continuous.

"On the other hand, the cost of the batteries is very great, and they require skilled attention, while their efficiency at maximum output is probably rather low; the automatic switches are a weak point, and any failure in this action would probably ruin the batteries at that station; the insulation of large batteries cannot be maintained at all high, and the numerous joints, in the presence of acid fumes, are a source of weakness. This system, in which the supply is entirely from accumulators, if it can be successfully worked in practice, possesses very great advantages."

Two defects are mentioned by Major Cardew in the transformer system—viz., that alternating dynamos cannot be run in parallel, and that no successful alternating motor is likely to be brought out.

The author ventures to think that these two difficulties are overcome, and that if Major Cardew were writing his remarks to-day he would not name them. All distributing cables should be laid underground. Many forms of conduit have been devised for the purpose of protecting the cables, but probably nothing will be ultimately used but ordinary cast-iron pipes. In the Bradford installation the cables are simply laid in the ground and covered with boards. Where cables are laid in conduits, they should be insulated with vulcanised rubber, as condensation is certain to take place inside the conduit, and if the wires are not insulated leakage will take place. But lead-covered cables are unnecessary where conduits are provided: they are adopted in some installations without conduits. In such cases they should be sheathed in iron to prevent mechanical injury. Time does not permit of descriptions of the meters used for measuring the current used by each house; but it should be taken as a principle that meters should be used, and not an annual charge per lamp.

COST.

The cost of installations of electric light varies very much, but it may be useful to the members to give them some actual figures of cost. An installation of about 2,000 16-c.p. incandescent lamps, supplied direct from dynamos driven by steam-engines designed and erected by Mr. T. Hewson, M.I.C.E., borough engineer, of Leeds, for the Leeds Corporation, cost in round numbers 50s. per lamp, including boilers, iron chimney, engines, dynamos, cables, lamps, and fixing.

Central stations vary even more than home installations, but an installation of 37,500 lamps, 10 c.p., for Leeds, including site, buildings, chimney, engines, dynamos, cables, transformers, and meters, will cost about 30s. per lamp; the plant to be capable of supplying two-thirds of the total number of lamps at one time with the necessary surplus power. This will leave the consumers to supply their own wiring, lamps and fittings, as in the case of gas, and this will probably cost £1 per lamp unless very expensive fittings are used.

The cost of working at Leeds, Mr. Hewson informs me, comes out at $\frac{1}{4}$ d. per 16-c.p. lamp per hour, and probably a 10-c.p. lamp can be supplied from a central station at the rate of $\frac{1}{8}$ d. per hour, without profit, but including interest and depreciation.

In the metropolitan area it is proposed to charge on a sliding scale at a maximum price of 8d. per Board of Trade unit (1,000 watt-hours). This will probably mean that the consumer of large quantities will be charged about 6d. per unit, which is equivalent to gas at 3s. 9d. per cubic feet. To this must be added the renewals of lamps, which, taking 1,000 hours as the average life, makes the cost of electric lighting equivalent to gas at 4s. 6d. per 1,000 cubic feet to the consumer.

Three years since electricity cost the consumer over an equivalent of gas at 7s. per 1,000 cubic feet. The reduction in the price of gas from its introduction was not by any means so rapid as that of electric lighting has thus been, and apart from the certainty of further development in the art of electric lighting, the lapse of patents alone (of which so many now fetter the work) will in a few years reduce the price far lower than it is to day. The cost of running 2,000-c.p. arc lamps may, perhaps, be put down at 2 $\frac{1}{2}$ d. per lamp per hour, to cover all charges, but not make a profit.

CONCLUSION.

Leaving the scientific aspects of the question, the author commends to the association the following conclusions:

That by reason of a corporation being able to borrow money at a cheaper rate than would be deemed a satisfactory profit to a company, and that it need not make a profit, it can supply electric light to its ratepayers far cheaper than a paying company could.

That any future discovery in electric lighting which would produce it more cheaply would, for long periods, benefit the shareholders of the company only, revisions in the price being at intervals of perhaps 10 years.

That the principle of keeping entire possession of the streets is one which the experience of all towns in regard to tramways, gas, and water companies has taught them should never be yielded.

That although a local authority may agree with a company to light a town for a shorter time than the 42 years named in the Act of Parliament, a company would only agree to this on receiving advantages equivalent to them to the reduction in time.

Again reminding the association that the capitalist has been let loose, and that the Board of Trade will grant provisional orders to companies where the corporation neglect or delay to do so, the author concludes with the hope that the interest of the members may be aroused, that they will rise to the occasion, and that the information contained in his paper will be of use to them in dealing with the question.

PROBLEMS IN ELECTRIC TRACTION.*

BY DR. LOUIS BELL, PURDUE UNIVERSITY.

(Concluded from page 29.)

The amperes on the car line varied from 0 to 90 and the volts from 405 to 480, averaging about 450. A sudden call for a large current invariably lowered the potential to about 410 and tended to slow the engine momentarily, for the governor only began to act some two seconds after the current rose; and so sudden are the variations in current that nothing short of compound winding can possibly keep the dynamo at anything like constant potential.

The electrical output varied greatly during the different hours of the day. Fig. 1 gives this variation of the output with the time in a very marked way. The heavy line gives the e.h.p. required hour by hour. The variation is very large, and causes a similar variation in the efficiency of the power station, since the main losses are nearly independent of the output.

Combining, now, the i.h.p. at the engine with the e.h.p. on the carline, and making proper allowance for the power consumed in the lamps and on the stationary motor line,

we have as the average efficiency of the power station $\frac{\text{E.H.P.}}{\text{I.H.P.}} = 40.7$ per cent. average throughout the day, and

for the maximum efficiency, $\frac{\text{E.H.P.}}{\text{I.H.P.}} = 65.0$ per cent. The

light line in Fig. 1 gives the variation of the efficiency throughout the day.

The coal burned during the day was 4,500lb. of slack, which is at the rate of 7.3lb. per i.h.p. hour, or nearly 16lb. per e.h.p. hour. We have shown in these facts by far the greatest source of loss in electric traction, both here and elsewhere. It is worth while considering in some detail the nature and cause of this loss, in how far loss at this point is necessary, and what means can best be taken to lessen it. The key to the whole situation lies in the immensely irregular calls for power in a tramway system.

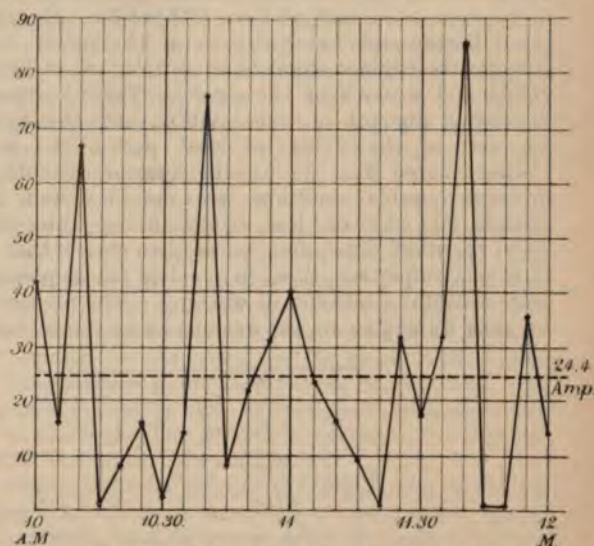


FIG. 1.—Variation of Current, La Fayette, Ind., Electric Railway.

The cause of this irregularity is obvious; the annexed diagram (Fig. 2) will give a feeble idea of its amount. It shows the variation of the current on the line as given by the five-minute readings between the hours of ten and noon on one of the days of test. Comment is unnecessary. But even this does not represent the real amount, for as a matter of fact the current is never even approximately constant for more than a few seconds at a time, and varies from nil to 60 or 70 amperes in a way that nothing but a continuous record can show. As a result of this the mean output is, on a system of this size, less than 25 per cent. of the maximum, which may be called for and must be furnished at any moment. As the system becomes larger the ratio of mean to maximum output increases until for a large system it may amount to one half. The value of this ratio on the Richmond (Va.) road, judging from Mr. Sprague's figures, rises to nearly this amount. The values will then range from .20 for a small road with high grades to .50 or .60 for a large road (40 or 50 cars) in a level region. Grades evidently tend to diminish its value considerably, though their effect may be partially counteracted in a small road by tact in arranging the schedule.

To supply power to such a system an engine must be able to give the maximum power demanded on very short notice, and will be habitually worked at from a fifth to a half of its full horse-power. This affects the efficiency of the system in two very pernicious ways—first, by requiring the use of a disproportionately large engine with friction to match; and second, by working that engine in a very uneconomical way.

As regards the first count, the friction of an engine is nearly independent of the load, quite as often decreasing under heavy load as increasing. It gradually increases with the speed, and slightly increases with increasing length of cut-off. As to the amount of friction, it varies, of course, very widely, but in modern engines of good make it will generally be from 5 to 10 per cent. of the full normal output.

This means, then, that if such an engine be worked or the average at a quarter of its full power, the loss from

* From the *Electrical World* (New York).

friction will be from 20 to 40 per cent. of the indicated horse-power, usually much nearer the latter figure than the former.

This is bad enough, but it is not the worst. When used under these circumstances, an engine is on the average working under conditions of expansion very far from economical. The cut-off is very much too short for advantageous working. The best point of cut-off is probably given by Emery's formula:

$$\frac{1}{r} = \frac{1}{1 + \frac{p}{22}}$$

Where r is the ratio of expansion and p the absolute pressure in pounds per square inch. Even this point of cut-off is probably rather small for ordinary engines. Applying the above formula to the case of the engine tested in these experiments, the best point would appear to be between one-fourth and one-fifth stroke. On examining the indicator cards taken at or near the point of average output, the engines seems to be cutting off at between an eighth and a ninth of the stroke. There is, therefore, a disastrous amount of condensation, and the final result appears in the 7.3lb. of coal per i.h.p. hour. A Corliss engine like the one in question should, if used under favourable conditions, give the i.h.p. hour for three pounds of coal or less, while under this erratically varying cut-off it requires more than twice that amount. It is very important, then, to avoid as far as possible these very wasteful conditions of working. The problem then is to work an engine on the average at its most economical

and require less than 5lb. of coal per i.h.p. hour, even under the variable load necessary. It should then be able, when belted direct to the dynamo, to give the electrical horse-power hour for about 7lb. of coal. The load being less variable in a large power station, conditions of economy are more easily reached, and as nearly as can be calculated from Mr. Sprague's data in the power station of the Richmond (Va.) road, the e.h.p. hour required about 9lb. of coal.

As to the amount of power actually needed to operate a tramway line, the tests made here show almost exactly 2.5 e.h.p. per car. This is a smaller value than would be obtained from a larger and more heavily loaded line. The diagrams given by Mr. Sprague show that on the Richmond line the power required was approximately 4 to 5 e.h.p. per car. The Richmond cars, however, are larger and heavier than those here. In general, the power required seems to be 3.5 e.h.p. per car. To furnish this output the engine should be capable of producing about 10 to 15 i.h.p. per car, at full (say $\frac{2}{3}$) cut-off, the former figure for large and level systems, the latter for small systems and those with excessive grades. It should then be practicable to bring the efficiency of the power

station, $\frac{\text{I.H.P.}}{\text{E.H.P.}}$ up to 70 per cent., in lieu of the 40 per cent. observed in these experiments. The efficiency of the Richmond system, which is operated by Armington and Sims engines running at 250 revolutions per minute, must be somewhere near this figure—certainly as high as 60 per cent. This efficiency, it should be remembered, is not

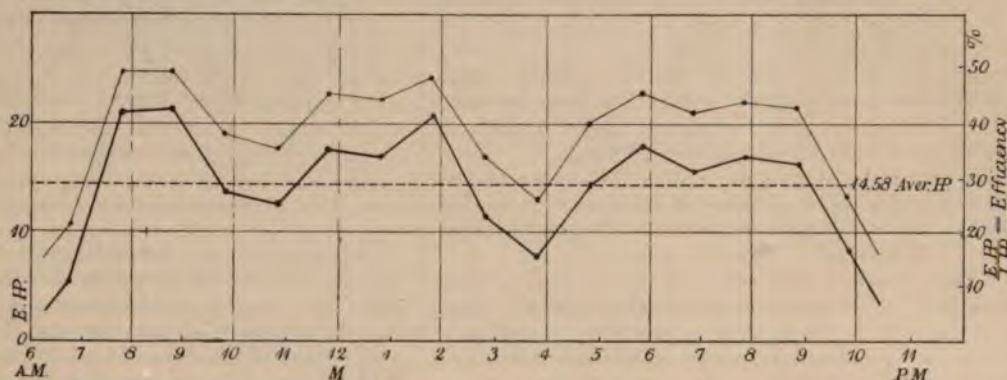


FIG. 2.—Variation of Electrical H.P. and Efficiency, Lafayette, Ind., Electric Railway.

point of cut-off, while retaining the power of responding to sudden, though brief, demands for several times the average horse-power. In the first place, these sudden demands are sometimes but for a second or two, generally for less than half a minute, and whatever the engine used, a heavy fly-wheel would be of great service in smoothing their irregularities of the output and helping the engine through a sudden emergency. Second, the engine itself should have a very wide range of cut-off to enable one to make the average expansion the most economical one. In an engine which must be habitually used at one-fourth power, the steam should be made to follow for nearly full stroke if necessary, in order to bring the average point of cut-off to the right value. Any valve-gear which cannot cut off beyond half stroke is decidedly objectionable, since it necessitates too large an engine and too great a ratio of expansion.

To avoid friction as well, the engine should be the smallest competent to furnish the maximum power; hence it should take high-pressure steam, and have a high rotational velocity. As regards application of power, it should be as direct as possible, avoiding countershafts and the like. All these considerations point distinctly to the use of high-pressure steam in a rather small high-speed engine capable of cutting off up to three-quarters stroke, driving a heavy fly-wheel, and belted direct to the dynamos. Such engines can be obtained, and are capable of giving the i.h.p. hour on 3lb. to 4lb. of coal. The day of low speeds and gigantic cylinders is fast passing by, and nowhere do they appear at less advantage than in work under extreme variations of load. An engine of the kind mentioned above would, under favourable conditions, have a coefficient of friction not exceeding 15 per cent. of the average i.h.p.,

secured at any great expense, for such a plant is quite economical in first cost as well as in operation.

The next experiments were to determine the losses on the line. These were found from observations of the fall of potential between power station and cars, taken both on regular and special trips. The efficiency of the line is a constantly varying quantity, changing, of course, with the position and ohmic resistance of the motors. A general average along the line showed an efficiency of 90-95 per cent.

Attention was next turned to the speed and efficiency of the motors. The observations were confined to a single car, No. 106, which was a good average car in its general performance. As a preliminary the resistance of the motors and connections was measured with the switch in each successive step.

These resistances measured cold were:

Step.	R.	Step.	R.
1.....	10.76	5.....	2.83
2.....	6.98	6.....	2.83
3.....	6.98	7.....	2.17
4.....	5.44		

The resistance of an armature cold was 1.2 ohms, measured from brush to brush.

Two spaces each of one-tenth mile were then measured off, one on a level, the other on a grade of 6.58 per cent. average.

Experimental runs were then made with car No. 106, carrying 19 persons and instruments. The total weight of car and contents was 8,200lb. The runs were made in each case with a flying start, each step of the switch being separately tested.

The results of an experiment on the level were as follows :

Step.	Miles per hour.	Volts.	Amperes.	E.H.P.
1	7.5	404	9.5	5.15
2	9.3	416	10.4	5.79
4	9.1	393	10.7	5.4
5	10.9	434	16.1	9.35
7	12.4	433	15.4	8.93

The somewhat anomalous result in step 4 is due to the very considerable drop in voltage.

From these experiments the efficiency of the motors may be deduced, and since the motors are geared down very nearly 12 times, the armature speed can also be obtained. In computing the electrical efficiency of the motors allowance must of course be made for increase of ohmic resistance due to heating, for self-induction, hysteresis, etc. Following Mr. Sprague's own figures, I have allowed 10 per cent. increase in resistance by heating. It is my firm conviction that this, under favourable conditions, will more than cover the above losses. Nevertheless, the loss due to hysteresis must be quite considerable. Computing this by Hopkinson's method for an approximate size of core, and an armature speed of 1,200 revolutions per minute, it appears that the energy spent in hysteresis may amount to somewhere nearly 500 watts. The loss of energy due to sparking may also rise frequently to a quite perceptible amount.

Computing, then, the electrical efficiencies under the various conditions, we have the following results :

Step.	Armature speed.	E.H.P.	Motor E.H.P.	$\frac{C_e}{C_e + E}$ Per Cent.
1	1,000	5.15	3.72	72.3
2	1,230	5.79	4.67	80.7
4	1,200	5.64	4.74	84.2
5	1,450	9.35	8.29	88.7
7	1,650	8.93	8.18	91.5

Unfortunately, a car motor does not lend itself at all readily to brake tests, the conditions of such a test being widely different from those under which the motor works. We can, however, obtain an approximation to the commercial efficiency by computing as nearly as practicable the coefficient of friction on track, and then applying this to the data obtained on a known grade to estimate the work actually done.

Assuming, then, a loss of 10 per cent. in friction of motors and gearing, in accordance with Mr. Sprague's own estimate, and using the data above, the coefficient of friction appears to be two per cent.—in other words, 40 lb. per ton. This is a high value, but, I think, justified by the condition of the track.

Substituting this constant in the formula used with the results of the grade test, we can obtain a close approximation to the commercial efficiency, and a check on the above estimate of 10 per cent. friction.

The grade tests were with the same car and load. The results were as follows :

Step.	Miles per hour.	Volts.	Amperes.	E.H.P.
2	26.73	347	27.2	12.65
4	4.2	403	27.4	13.47
5	9.3	409	31.3	17.14
7	6.2	365	32.4	15.85

The general voltage here was rather low, produced in part by the location of the grade relative to the power station, and mainly to heavy demands for current during the test. It serves to emphasise what I have previously mentioned, the advantage of using compound wound dynamos on tramway work.

Computing now the electrical efficiency by means of the above data :

Step	Armature speed.	E.H.P.	Motor E.H.P.	$\frac{C_e}{C_e + E}$ Per Cent.
2	333	12.65	5.06	39.9
4	545	13.47	7.98	59.3
5	840	17.14	13.04	76.1
7	830	15.85	12.50	78.9

Step 1 was not tried on the hill on account of endangering the field-coils. Notice, for example, that in case of step 2 there is 7.59 e.h.p. spent on internal work. No coil can stand such treatment for any length of time, and with this light it is quite easy to see why fields and arma-

tures burn out. On a grade like this, nothing short of full power should ever be used.

Compute now the actual work done by the motors on this grade, using the above data and the friction coefficient previously found. We have then virtually the brake horse-power, and hence the commercial efficiency

Step.	M.E.H.P. 10 per cent.	B.H.P.	$\frac{B.H.P.}{E.H.P.}$
2	4.56	4.67	36.9 per cent.
4	7.19	7.65	56.9
5	11.74	11.80	67.6
7	11.35	11.61	73.2

The agreement between the second and third columns shows that the estimate of 10 per cent. for friction of motors and gears was substantially correct. A second approximation could, of course, be deduced. It appears therefore that the motors with their gears may reach an efficiency of over 80 per cent. on the level, or over 70 per cent. on a severe grade when used under favourable conditions. When used with the lower steps of the switch, the resistance of the field-coils is so high as to reduce the efficiency enormously. In other words, when the cars run slowly they do so at the expense of greatly diminished efficiency. Still, less power is used, and if the field-coils are well insulated, the lowest step of the switch sufficient to give the required speed will be the most economical one. On grades, however, the fifth or seventh step should be always used to avoid excessive heating. The very high ohmic resistance of these motors is a source of continual loss, as has been pointed out in detail by Mr. Snell, and is the cause of unnecessarily great destruction of field-coils. It may be possible to so insulate the coils as to withstand the roasting to which they are too often subjected, but this is a questionable way out of the difficulty.

From observations on the cars during regular trips, the average electrical efficiency in ordinary use appears to be about 75 per cent., and the commercial efficiency of motors and gearing 65 to 70 per cent.

We are now in a position to obtain the approximate efficiency of the entire system

The mean value for this line as at present worked is about 25 per cent. The chief cause of this low efficiency has been already pointed out. The figure will probably be considerably increased before long by the increasing use of stationary motors, which will raise the mean electrical output to something like the proper figure. As a system increases in size the efficiency will rise, and in a system as large as that at Richmond, the total mean efficiency would appear, from the data obtainable, to be a little over 40 per cent. This may seem a low figure, but it should be remembered that traction work is probably the least favourable to high efficiency of any task to which an electric motor can be put.

Most of the losses incurred are unavoidable. Engines will not run without friction, dynamos are not of ideal efficiency, line wire will have resistance, an electrical current will generate heat in the motors, and gears will grind and wear. Losses like these cannot be avoided or reduced below certain limits. These limits are not easy to set, but one can safely say that a total mean efficiency, B.H.P. of anything over 50 per cent. would be a very remarkable performance for a traction system in actual use.

I do not think that 60 per cent. is likely to be reached without very radical improvements. This applies, of course, to the direct supply systems. The storage battery requires a separate investigation. In that case the power stations can be worked to rather greater advantage than with direct supply, since the load can be made much more regular. There is no loss by line wire, but there is a very serious loss in the accumulators themselves. The laboratory efficiencies of storage batteries rise to a most tempting amount, 80 per cent. and over, but the irregular discharge rate necessary in operating a tramway is even more disastrous to the efficiency of a storage battery than to the efficiency of an engine. With any accumulator now made, a mean efficiency of over 65 per cent. is

doubtful under the conditions which exist in tramway work. There is great need of careful tests under some-thing like working conditions, but, so far as I am aware, none have been published, at least none of any scientific definiteness. I may here remark that, with very few exceptions, the reports published on electrical traction work are models of how to avoid giving definite information.

Perhaps the most serious charge against the accumulator is its very great weight. It appears to require about 3,500lb. of battery to operate a car successfully, and this amount must be carried as well as the passengers. Of the total electrical output, then, something like 25 per cent. is employed in dragging around this dead weight. But this is not all. Sit down with a list of storage batteries and compute the weight required to furnish the car, say 10 e.h.p. The fact at once appears that if we undertake to supply from storage batteries the same amount of power we supply from a line, we shall need something like twice the above weight of storage battery. In short, the weight of battery is reduced by reducing the supply of power.

Nevertheless, the storage system is deserving of consideration. Each car is a unit, there are no conduits or overhead wires, there is lessened danger of breakdowns, and independence generally. If the storage battery comes to be of reasonable durability and weight, it will furnish an ideal solution of the tramway problem, particularly for city work where overhead wires are a nuisance and conduits are troublesome.

Given a mean efficiency of 60 to 70 per cent. for the accumulators, it is easy to form a pretty clear idea of the total mean efficiency of the storage system. The power station will be somewhat more efficient than with direct supply, $\frac{\text{E.H.P.}}{\text{I.H.P.}}$ being perhaps 80 per cent.; the batteries

will be of, say, 65 per cent. efficiency, and finally, the motors will be about as before, giving a total efficiency of a little less than 40 per cent. In practice this is diminished by the fact that for the same service the storage system car would require from a fourth to a third more power on account of its constant load of battery. So far as efficiency is concerned, there seems to be little prospect of the storage system equalling direct supply, since the loss on the line is so small compared with that in the battery.

Probably the most effective rival of electricity is the cable traction system, and it is well to look into its efficiency a little. Facts are not particularly easy to get at. Some of the theoretical discussions of transmission by wire rope give a preposterously high efficiency. A valuable paper, however, in the *Journal of the Association of Engineering Societies*, September, 1888, gives some interesting and authentic figures as to efficiency, details of construction and cost.

The St. Louis and Western cable road, having a cable in one piece 34,600ft. long, required 185 h.p. to drive the empty cable at the rate of eight miles per hour. Regular capacity of the road 40 cars (20 trains of grip and car). Under ordinary conditions of traffic 180 to 190 h.p. additional was required to operate these cars, 9.95 h.p. per train. Curves are numerous on the road.

The Fifth-street-road, Kansas City, operates 40,000ft. of cable. The conditions of working are better than at St. Louis, there being few curves. Twenty trains are operated, taking under usual conditions 280 i.h.p., 120 of which is required to drive the cables at the rate of eight miles per hour, leaving 8 h.p. per train as the power required.

In these roads, then, 50 to 60 per cent. of the indicated horse-power seems to be applied to doing useful work.

It is instructive to compare this performance with that of the Richmond electric road, which operates single and double track, covering 8.8 miles of streets, and 40 cars aggregating almost exactly the same weight and seating capacity as the above 20 trains. The mean electrical output at the power station is per car 4.5 e.h.p. Making due allowance for loss in the power-station, it appears that the total power required to operate the system is about the same as in the Kansas City cable line, and distinctly less than in the St. Louis cable. The curves and grades

Richmond are more severe than in the Kansas City line.

We may conclude, then, that in the case of good-sized systems the power required to operate is nearly the same with cables and electricity, the former having the advantage on short and easy lines, the latter on long and difficult ones. On smaller systems electricity has a decided advantage, since the loss of power in the motors depends on their number, while the loss in dragging a cable is constant.

But there is another side to this comparison, the economic one. A cable road costs 50,000d l.s. to 75,000dols. per mile, owing to the large and complicated substructure. This does not include power stations or rolling stock. This cost is four or five times greater than for an electric overhead road, even under unfavourable conditions, and something like twice as great for an electrical conduit system. This comparison supposes the electrical road to be laid and wired in the most efficient and permanent way.

Under ordinary circumstances the difference in first cost would be even greater. The difference in running expense is not so easy to estimate. Not far from the same amount of power is required, though it is probably procured at rather less expense of coal in the cable system. The number of employes cannot be widely different, the difference being of little moment. The cable conduit, however, requires decidedly more care than the electric line, supposing the latter to have been properly put up in the first place.

As to repairs on an electric system using overhead wires, the line if properly put up and occasionally aligned should give very little trouble. The trolley of whatever description is subject to constant wear, and must frequently be renewed or repaired, and the brushes rapidly wear out. On some lines the wear of brushes amounts to almost a set per week per car. There is great chance for improvement here. The field-coils now and then burn out, in some cases frequently, and occasionally an armature is damaged. On a cable line the cable itself is a considerable item of expense. Its life may be from six to 18 months, though occasionally only a few weeks; and the expense of renewal is considerable. The grips are subject to continual wear, the dies that form the jaws generally lasting only a week or 10 days. The running gear along the line requires constant watchfulness and attention and the minor repairs on this must be considerable. As regards the comparison of actual operating expenses it is almost impossible to get definite information. Both cables and electricity are distinctly cheaper than horses. Reports from the Chicago cable roads indicate expenses about 50 per cent. of the cost of operating by horses. From this the figure may rise to 75 per cent. Reports of anything like a definite kind from electric roads are scarce. Such scattered figures as can be collected tend to show that the operating expenses are about the same as for cables on systems of the same size. Details of operation vary so much from place to place that it would at present be unjustifiable to say more than this. The detailed reports from electric roads have for the most part been from very small ones. A recent one from the Davenport, Ia., road shows expenses 97 per cent. of those with horses the previous year, and net profit three times as great. This road operates only four regular cars. One or two small English roads report something of the same kind, slightly diminished expenditures and greatly increased receipts.

In closing, it seems worth while to say a word about the use of electricity for ordinary railroad work. In elevated roads there can be little question about the matter; the smoke and dust of the locomotive are quite enough to condemn it, and as the consumption of coal is over 6lb. per h.p. hour, an electric system can push it hard in the matter of economy. In ordinary cases, however, there is no call for sacrificing economy for the sake of the characteristic advantages of an electric system. It is quite possible for a locomotive to give the horse-power hour on 4lb. of coal, a figure which can probably be reduced. This leaves no very large margin for the double transformation of an electric system. In fact, so long as we have to depend on the steam-engine and dynamo for our supply of electricity, competition with the direct use of steam in locomotives will be hopeless. Even water power will not be of much avail, and the longer the line to be operated the less chance of success.

If we could get electricity directly from heat in any economical way, the problem of power would be solved.

Finally, with regard to electric traction systems, most lines of road are not laid and wired with sufficient care, and most of the minor difficulties in operating come from this fact. A line with track hastily and imperfectly laid, with wiring carelessly put up on rickety poles, and imperfectly aligned, will surely encounter plenty of small but exasperating difficulties and bills for repairs that will be anything but pleasant. A vigilant system of car and line inspection will avoid most of the little accidents that interrupt traffic, and will more than pay for itself in lessened repairs. With a carefully constructed line, and a properly designed power plant, electric traction becomes thoroughly reliable and remarkably economical. Without these it may be very uncertain in its operation, and while it will nearly always pay, the size of the dividends will not be pleasant to contemplate. If much power is to be used for stationary motors, it is better, and in the long run cheaper, to divide the plant than to rely entirely upon a single engine.

I cannot close this paper without expressing my obligation to Mr. Hawter, superintendent of the road, who has facilitated this investigation in every way possible, and to Messrs. F. W. Brady and W. J. Lutz, post-graduate students in this university, for most efficient aid throughout the tests.

ELECTRIC STREET RAILWAYS.

[Not long since the Bentley-Knight Railway Company, in furtherance of their business, issued the following comparison. Of course, their system is not a storage system; hence we may take it that the comparison is really the strongest case against storage that can be made. Other people are as strongly impressed with the value of the storage system, and it becomes them to reply to the case presented by the Bentley-Knight Company—if, indeed, they have any reply.—ED. E.E.]

A COMPARISON BETWEEN THE STORAGE BATTERY AND DIRECT SYSTEMS.

No plan of street transit could be more attractive at first sight than that of a self-propelled car, carrying within itself its own energy, independent of any connection with line wires, and dispensing with expensive conduits and unsightly elevated conductors.

On the advent of an apparently practicable storage battery in 1881 all these advantages were claimed for it, and it was enthusiastically received as a most promising addition to the mechanism employed in electric light and power distribution. Although never contemplated as a competitor to direct system electric lighting, it was thought to be a valuable adjunct thereto as a means of utilising the unoccupied time of the steam and electric plants employed in the direct system; most extraordinary efforts were made to perfect it, and millions were expended in its development. It can be readily seen that a practicable storage battery would substantially double the capacity of an electric light station, the machinery in which lies idle during the greater part of the day. It proved a complete and disastrous failure.

Since the European experiments of 1882 little or no material progress has been made in the practical use of the storage battery for street car purposes, and it is our belief, based on most careful investigation, that its radical structural difficulties cannot be overcome. The "boom" has, however, again been started in this country, and our larger cities have each been favoured with the attention of the several "inventors" or their exploiting companies. The "storage" car rarely fails to make an excellent exhibit, and the possible investor is almost always favourably impressed. Incalculable harm is thereby done to commercial electric railway systems, and this paper has been prepared with the desire that the facts may be laid before the American street railway interest.

It is often assumed that self-contained motors have a decided advantage over those which are in some way dependent upon the road-bed, or upon a connection with a stationary source of power. The basis of this assumption has never been well defined. Analysis shows the supposed advantages to be almost wholly imaginary, and in any case not worth their cost. Both in steam and storage battery cars the actuating force must be generated upon the vehicle, and the generating apparatus must be carried by the vehicle. In the steam locomotive, the boiler, furnace, and fuel make up by far the largest part of the total weight—the cylinders and driving-

gear being but a fractional part of the mechanism. The same is true of the storage battery car, the largest part of the weight carried and space occupied being required by the batteries which generate the current.

It is well settled that small, isolated power plants are expensive and inconvenient to operate, and that certain forms of energy are well adapted to generation at large central stations, and to transmission and distribution along given routes. The application of this general principle to locomotion has long been desired. It is accomplished to a certain degree by the cable road. The conspicuous advantage gained in the use of electric motive power for street railway work comes from the ease with which that power, generated by the most economical methods at a central station, can be divided up and distributed to moving cars at any point along a railway line, each car being thereby enabled to draw from the main supply exactly what power it needs for any load at any time or place.

To understand the position of the storage battery motor, as contrasted with the *directly supplied* motor, it is necessary to compare the two in detail. We will consider, as representing the *direct* system, the case where the electrical conductors are enclosed in a sub-surface conduit, this being the only system applicable to city streets, and at the same time being far more expensive than where the conductors are carried overhead. It is no objection to the conduit system to say that it necessitates a special construction along the line. In the early days of steam it was expected that the locomotive would traverse the ordinary highways; and when it became evident that a specially constructed roadway, graded and provided with rails was essential, many declared the steam railway a failure. At the present time, special constructions, such as are necessary for cable or electric roads, or elevated railways, cannot be objected to without some specific reason.

As subsequently shown, the interest upon the first cost of a conduit is much less than the loss constantly entailed by carrying a storage battery with each car, and by the conversion of the energy through the storage battery.

(To be continued.)

COMPANIES' MEETINGS.

INDIARUBBER, GUTTAPERCHA, AND TELEGRAPH WORKS COMPANY.

A half-yearly general meeting of the Indiarubber, Guttapercha, and Telegraph Works Company, Limited, was held on the 11th inst., at the City Terminus Hotel, to obtain the sanction of the shareholders to the payment of an interim dividend of 5 per cent.

Mr. S. William Silver, who presided, observed that the general trade of the Company had been somewhat in excess of that of any previous year, and their electrical and telegraph departments had been fairly occupied. One of their steamers returned on Saturday last after having nearly 1,000 miles of cables successfully in every respect, notwithstanding the peculiar character of the coast, the ground seas, the delta of the Congo river, and the varying nature of the bottom. He concluded by proposing the payment of a dividend of 5 per cent., or 10s. a share tax-free.

Mr. Matthew Gray seconded the motion, which was carried unanimously.

LONDON ELECTRIC SUPPLY CORPORATION.

An extraordinary general meeting of the London Electric Supply Corporation, Limited, was held on Monday at the City Terminus Hotel.

The Earl of Crawford and Balcarres, who presided, reminded them that when the annual report was submitted at their meeting in December, he stated that the Directors were about to lay the accounts of the past year before them, and that was the main object of the present meeting. The Board had been greatly strengthened by the addition of Mr. Forbes, who had been appointed vice-chairman of the Directors, and chairman of the Finance Committee. The form in which the accounts had been submitted to the meeting was mainly upon the lines laid down by the Board of Trade as the form in which the accounts of such companies as theirs were to be presented in the future, and he might add that the accounts were based somewhat on the lines of those annually laid before Parliament by gas companies. He then moved the adoption of the accounts.

Mr. J. S. Forbes, in seconding the motion, explained the accounts in detail. He stated that the ordinary capital of the Company was £1,000,000, in £5 shares, and he reminded them that at the general meeting last December £250,000 of preference capital was authorised to be created. Altogether the capital called up amounted to £586,000, so that there was a large amount remaining to be called up to meet their requirements from time to time. Their expenditure to March 31 had been £394,957. On the first 15 months' working, to the end of December, there had been a small loss—£382; but at the inception of such a novel undertaking as theirs no business man would expect any great result. That an improvement had already taken place was shown by the fact that on the working for the first three months of the current year there had been a profit of £548, and they all believed that the results in the future would be very much better.—The motion was adopted.

The **Chairman** subsequently addressed the meeting on the progress which had been made since their last meeting with the works at Deptford, observing that they would certainly have everything ready there for the supply of current and for relieving the Grosvenor station of 15,000 or 16,000 lights before the 1st October, before which they would not be able to break up the streets. The provisional order granted to them by the Board of Trade covered a very large portion of London. The main principle of Major Marindin's report was that where it was possible two companies should be put into the same area. Their Company quite approved of that, relying, as they did, upon being able to do their work in a proper and businesslike manner. They had at present competition in St. George's, Hanover-square, St. Margaret's, Westminster, Chelsea, St. Martin's-in-the-Fields, and Marylebone. Altogether, he thought the shareholders had every reason to be satisfied with their property.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY.

The half-yearly general meeting of this Company was held on Tuesday at the offices, Old Broad-street.

In the absence of the Chairman of the Company (Sir Daniel Gooch), **Mr. F. Rawson** presided, and stated that the meeting was a formal one, there being no resolutions to propose and no report to submit. The warrants for the interim dividend would be posted that afternoon. During the past half-year they had done a fair share of cable work, especially as regarded the wire-covering and other general business of the Company. Their ships had been engaged in triplicating a portion of the Eastern Extension Company's system between Java and Western Australia and in laying a line between the Cape and the Portuguese settlement of Mossamedes, on the West Coast of Africa. They had also effected some cable repairs on the West side of the Atlantic, and the steamship "Calabria" continued on the charter she was engaged in at the time of the last annual report.

COMPANIES' REPORTS.

ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION, LIMITED.

Report to the shareholders, to be presented at an extraordinary general meeting on July 22.

Introductory.—The Directors have pleasure in advising the shareholders that the mortgage debentures which were offered for subscription in April last have all been allotted, the applications for the same having been in excess of the amount to be allotted. As a result of obtaining this additional capital, the Directors have been enabled to give effect to the policy indicated in former reports, of extending the capacity of the Corporation for carrying on its manufacturing operations; and a provisional contract has been made to acquire the business and properties of the engineering establishment known as the Falcon Works, at Loughborough, in Leicestershire, upon the terms mentioned below. The Directors have also entered into a provisional agreement with the Australasian Electric Light Power and Storage Company for the transfer to the Corporation of its business as a going concern. The Australasian Company, which is one of the companies formed in 1881-82 to work the Brush and Lane Fox patents, has also acquired, by its amalgamation with the Edison Indian and Colonial Company, the patent rights of Edison in India, Australasia, and South Africa. The policy of reacquiring the rights held by the subsidiary companies has already met with the full approval of the shareholders, and the terms of the proposed arrangement, which, in the opinion of the Directors, are fair and equitable to both companies, are mentioned below. The memorandum of association of the Corporation, which was drawn up many years ago before the present requirements of an electrical manufacturing and contracting company were realised, has been found to be inadequate. It is therefore necessary for this, as well as for a variety of minor reasons, to extend and amend the memorandum of association, and as this can be legally accomplished only by means of a reconstitution of the Corporation, the Directors have given the whole position their very careful consideration, and now submit for the approval of the shareholders the scheme of reconstruction mentioned below. The Directors take this opportunity of announcing the settlement of the litigation with the Edison-Swan United Electric Light Company in regard to incandescence lamp patents. Under the arrangement come to, the Edison-Swan Company accept a license to use the Lane Fox and other incandescence lamp patents held by the Corporation, and they pay the Corporation a royalty upon the basis of the number of lamps made, but subject to a maximum payment per annum. The Corporation, on the other hand, give up the manufacture of incandescence lamps, and agree to buy from the Edison-Swan Company on the most favoured terms to dealers, until the expiry of the Edison patent. The Edison-Swan Company waive all claim to damages, and it will be remembered that in regard to the Cheesbrough patent, the decision of Mr. Justice Kay was against the Corporation and no appeal was entered, but the Corporation agree to pay the Edison-Swan Company's taxed costs. The arrangement, which applies only to the United Kingdom, fully protects the Corporation's customers, who will not be subjected to any inconvenience or expense. The only other litigation in which the Corporation is engaged is that relating to compound winding of dynamos. It will be remembered that in the case against the Orient Steamship Company, which was tried in England in December last, the Brush patent for this process was upheld; on the other hand, the action brought by Messrs. King, Brown, and Co., in Scotland, for the reduction of the patent has been decided in favour of the plaintiffs. This decision is now being

appealed against, but the issue will not in any way affect the manufacturing business of the Corporation. With regard to the general business of the Corporation, the Directors are glad to be able to report very satisfactory progress. It is not practicable to specify in detail the important contracts at present on hand and in view, but it will be interesting to the shareholders to know that the orders booked during the first six months of this year equal in amount the total volume of last year's business, and when it is remembered that the past year showed a very considerable advance upon the business done in previous years, it will be admitted that the present position of the Corporation is very satisfactory, and justifies sanguine expectations in regard to the future.

Amalgamation with Falcon Company.—The Falcon Company was established in 1883, to take over the works and business of the Hughes Engineering Company. The capital is £60,000, divided into 50,000 preference shares of £1 each, and 10,000 ordinary shares of £1 each. The company has, since its formation, carried on successfully the business of building locomotive and other engines, as well as tramway and other cars. For the four years ending June, 1886, the full dividend of 7 per cent. per annum was paid upon the preference shares, in the following year a dividend of 2 per cent. was paid, and the dividend paid in 1888 on the preference shares was 5 per cent. The property consists of freehold land covering an area of over seven acres, and several buildings, well adapted to the purposes of iron and brass founding, engine and car making, stores, offices, dwellings, etc., and on the whole the property is well adapted for the Corporation's heavy electrical work. The price to be paid for the whole of the business as a going concern is £55,000 in fully-paid shares of the new Company, and £1,000, payable half in shares and half in cash, to cover expenses incidental to the liquidation of the Falcon Company. The Directors of the Corporation consider the arrangement very advantageous for the following, among other reasons: Additional manufacturing works are absolutely necessary for carrying on the business of the Corporation. The works of the Falcon Company are suitable for the purposes of the business. The situation of the works is very convenient in respect of economy of manufacture, and of conveyance of goods and materials. The purchase price is to be in shares, involving no cash expenditure, except such as may be necessary for extensions, and the amount mentioned above for expenses. The business of the Falcon Company is carried on at a profit, and as it is proposed to continue the same the capital expended on the purchase will not be unproductive during the period of transition necessary for the adaptation of the works to the new requirements. There will be no loss of time in the acquisition of the property, and this, in view of the urgent demand for a much larger output than the Corporation is at present able to deal with, is an advantage of very great importance, and one that could not be as effectually secured by any other available means.

Amalgamation with Australasian Company.—The Australasian Company was formed in 1882 to work the Brush and Lane Fox patents in the Australasian Colonies. The company, as already stated, subsequently amalgamated with the Edison Indian and Colonial Electric Company, and secured the patent rights of Edison in India, Australasia, and South Africa. It has also secured the sole agency under the Swan lamp patents and other rights. The company therefore occupies an exceptionally strong position in regard to some of the principal patents which control the more important branches of the electrical industry. Last year the company carried out, by means of apparatus supplied by the Corporation, the important contract for lighting the Melbourne Centennial Exhibition, and altogether the company has done important work in organising the business in the colonies, but it has not so far been able to work at a profit, the volume of business having during the past years of depression been but small. The prospects now, however, have materially improved. Under the agreement with the Australasian Company hitherto in force, the Corporation has been practically precluded from doing business in Australasia, except through the medium of the Australasian Company, and in the opinion of the Boards of both Companies the Corporation will, by reason of its manufacturing facilities and greater experience in the field of electrical work, be in a better position for developing the business in the colonies than the Australasian Company. The present capital of the company is £202,386, divided into shares of a variety of classes, but under a scheme of reconstruction which is now before the shareholders of that company, it is proposed to consolidate all classes of shares, and to reduce the aggregate capital to £78,065. The price to be paid by the Corporation for the transfer of the business as a going concern is £45,000, payable in fully paid shares of the Corporation, or of the reconstituted Brush Company, as mentioned below, and £1,000 payable half in shares and half in cash to cover the expenses of winding up.

Scheme of Reconstruction.—It is proposed to transfer all the assets and liabilities of the Anglo-American Brush Electric Light Corporation to a new company, to be registered under the title of the Brush Electrical Engineering Company, Limited, with extended memorandum and articles of association. The present subscribed capital of the Corporation is 52,314 shares of £5 each = £261,570. (Of these 26,803 shares are £5 fully paid up and 25,511 are £5 each with £4 per share called up.) The capital of the new company is to be £750,000, divided as follows: £300,000 in 150,000 6 per cent. preference shares of £2 each; £450,000 in 150,000 ordinary shares of £3 each. The proposal is, that the shareholders of the Corporation shall receive in respect of each £5 fully-paid share held by them, one preference share of £2 and one ordinary share of £3 in the new company. That the Falcon Company shall receive £55,500 in 11,000 preference shares of £2 each, and 11,000 ordinary shares of £3 each, and that the Australasian Company shall receive £45,500 in 9,100 preference shares of £2 each; and 9,100 ordinary shares of £3 each. The arrangement will involve the voluntary liquidation of the Anglo-American Brush Electric Light Corporation, and in view of the

desirability of removing the distinction at present existing between the partly paid and fully paid shares by which the market value of the shares is affected, it is proposed that the liquidators should call up the £1 per share remaining unpaid on the 25,511 shares. It will be necessary to obtain the sanction of the debenture holders to the scheme, but as it is proposed to issue debentures of the new company of equal amount to, and on the same terms as, the present issue, the debenture holders will, in view of their security being materially increased by the accession of the assets of the Falcon and Australasian Companies, have every reason for acceding to the arrangement. The share and debenture capital account of the new company will stand thus: nominal share capital, £750,000; mortgage debentures, £75,000.

Distribution of Capital.

	Deben- tures.	6 per cent. pre- ference shares.	Ordinary shares.	Total.	
				Deben- tures.	Shares.
	£	£	£	£	£
To be issued to debenture holders of Brush Corporation	75,000	...	...	75,000	...
To be issued to present shareholders of Brush Corporation..	...	104,628	156,942	...	261,570
To be issued to Falcon Company	...	22,200	33,300	...	55,500
To be issued to Australasian Company	...	18,200	27,300	...	45,500
	£75,000	145,028	217,542	75,000	362,570
Balance unissued..	...	154,972	232,458	...	387,430
	£ ..	300,000	450,000	75,000	750,000

The Directors are advised that the subdivision of the capital in the way proposed will tend to appreciably improve its market value, and the numerous precedents for this course afforded by the large railway and other companies strongly support this view. It is obvious that as a result of this proposed subdivision of the capital, the shareholders will have much greater certainty of receiving satisfactory dividends upon at least a portion of their holdings than if the profits of the business had to be distributed over the whole of the capital alike.

Conclusion.—The Directors are of opinion that the present is a very favourable opportunity for carrying out a scheme of this nature, which has been under their consideration for some time past, but which, owing to the late unfavourable condition of the industry, and to the want of adequate working capital necessary for effecting the enlargement of the works, has not been practicable before. After a long period of depression, the business has now entered upon a new and more encouraging phase, and by taking energetic steps to cope with the increasing demand for electrical work of every kind, the Company will, it is confidently believed, forthwith place itself in a dividend paying position. The character and the amount of the work now carried on by the Corporation, and the prospects of future business are such that the Directors see no reason why the new company should not, from the date of its registration, earn sufficient profits to admit of regular dividends being paid from the outset. The Board are of opinion that the opportunity of the reconstruction should be taken to strengthen the Directorate. They propose to offer seats at the Board to one director of the Falcon Company, and one director of the Australasian Company, and they are in consultation with some of the leading shareholders as to the advisability of appointing one or more additional Directors. In conclusion, the Directors refer to the notice convening a special meeting of the shareholders and the resolutions set out, and they strongly recommend these resolutions for adoption, in the full conviction that the course suggested will be found to be in every respect beneficial to the shareholders.

The extraordinary general meeting will be held at the Cannon-street Hotel on the 22nd July, at 2 p.m., to consider and, if deemed advisable, to pass, either with or without modification, the following resolutions:

Resolution No. 1.—That the provisional agreement entered into between the Corporation and the Australasian Electric Light, Power, and Storage Company, Limited, dated the 12th day of July, 1889, and submitted to the meeting be, and the same is hereby sanctioned, adopted and confirmed, and that the Directors be authorised to carry the same into effect with or without modifications.

Resolution No. 2.—That in accordance with the terms of the agreement mentioned in the above resolution, the Directors shall, if necessary, issue to the liquidators of the Australasian Electric Light, Power, and Storage Company, Limited, or to such persons and in such manner as the liquidators shall in writing direct, fully-paid £5 shares in the capital of the Corporation, not exceeding 9,100 in the aggregate.

Resolution No. 3.—That it is desirable to reconstruct the Anglo-American Brush Electric Light Corporation, Limited, and that with a view thereto the Corporation be wound up voluntarily, and that J. B. Braithwaite, jun., and E. Gerecke be, and they are hereby, appointed liquidators for the purposes of such winding up.

Resolution No. 4.—That the said liquidators be, and they are hereby, authorised to consent if required to the registration of a new company, to be named "The Brush Electrical Engineering Company, Limited," with a memorandum and articles of association which have already been prepared with the approval of the Directors of the Corporation, but which are to be subject to such alterations and modifications (if any) as may be found expedient.

Resolution No. 5.—That the draft agreement submitted to this meeting and initialled by the Chairman for the transfer of the business and property of this Corporation to the new company shall be, and the same is hereby approved, and that pursuant to section 161 of the Companies Act 1862, the liquidators shall be, and they are hereby, authorised to enter into an agreement with such new company (when incorporated) in the terms of the said draft, and generally to carry the same into effect with such (if any) modifications as the liquidators may find expedient.

Should resolutions 3, 4, and 5 be passed, either with or without modification, by the required majority, they will be submitted for confirmation as special resolutions to an extraordinary meeting, which will be subsequently convened.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY.

Sixth annual report to be presented at the ordinary meeting of shareholders to be held at the Cannon-street Hotel on Tuesday, July 30th, at 12 o'clock:

The Directors herewith present their report and the accounts for the year ending 30th June, 1889. The sale of lamps and fittings has progressed in a satisfactory manner during the year, and has resulted in a credit balance of £47,729. 5s. 9d.; to this must be added the sum of £25,123. 9s. 7d., the balance of account for the year ending 30th June, 1888, making a total of £72,852. 15s. 4d., out of which the Directors have appropriated the sum of £28,815. 14s. 2d. to meet losses realised on finally disposing of sundry installations taken over at the date of the amalgamation, and have, under clause 89 of the articles of association, created a reserve of £4,595. 10s. 10d., and they recommend the appropriation for dividend, in accordance with clause 87 of the articles of association, of seven per cent. upon the amount paid up on the A shares, in respect of the year ending 30th June 1889, and of three per cent. further on account of the arrears of preferential dividend on the A shares, in respect of the year ending 30th June, 1884. The supply companies are establishing central stations in London and the provinces, which must lead to a considerable extension of the business of the Company. The appeal of the Company from the decision of Mr. Justice Kay was heard before Lords Justices Cotton, Lindley, and Bowen, who reversed Mr. Justice Kay's judgment, and decided that Mr. Edison's patent, 10th November, 1879, was valid. The Brush Company gave notice of their intention of appealing to the House of Lords, but a settlement has been arrived at by which the case will not be carried to the House of Lords. The Brush Company give up manufacturing incandescent lamps, and they pay the taxed costs of the action. Viscount Anson and Mr. Ernest Villiers retire from the board, and offer themselves for re-election as Directors. Messrs. Welton, Jones, and Co. (late Messrs. Quilter, Welton, and Co.), the auditors, also retire, and offer themselves for re-election.

EASTERN TELEGRAPH COMPANY.

The report of the Directors of the Eastern Telegraph Company for the half-year ended March 31, 1889, shows that the revenue amounted to £435,932, from which are deducted £92,448 for the ordinary expenses, and £48,665 for expenditure relating to repairs, renewals, and laying of cables, etc., during the half-year. After providing £3,710 for income tax there remains a balance of £291,107, to which is added £36,616 brought from the preceding half-year, making a total available balance of £327,723. From this amount there has been paid interest on debentures and debenture stock £28,274, dividend on preference shares £20,474, and an interim dividend of 1½ per cent. on the ordinary shares, absorbing £50,000—a total of £98,748, leaving a balance of £228,974, from which £118,000 has been carried to the general reserve. The Directors now recommend the declaration of a final dividend for the year ended March 31, 1889, of 2s. 6d. per share and a bonus of 3s. per share, amounting together to £110,000, both payable on the 18th inst., tax free, and making, with the three previous payments on account, a total distribution of 13s. per share, or 6½ per cent. for the year on the ordinary shares, the balance of £974 to be carried forward to the next half-year. The revenue includes £81,441 dividend and bonus for the half-year upon the Company's investments in the Eastern and South African, the Black Sea, and the Direct Spanish Telegraph Companies.

DIRECT UNITED STATES CABLE COMPANY.

The Directors of the Direct United States Cable Company, Limited, have decided to recommend a final dividend of 3s. 6d. per share, tax free, such dividend to be payable on and after the 27th inst., making, with the interim dividends already paid, 3½ per cent. for the year ended June 30 last, carrying forward a balance of £2,719. Notice is also given that the register of transfers will be closed from the 12th to the 26th July, both days inclusive.

CITY NOTES.

Brazilian Submarine Telegraph Company, Limited.—The receipts of this Company for the week ended July 15 amounted to £4,150.

Western and Brazilian Telegraph Company, Limited.—The traffic receipts for the week ended July 12, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,793.

Eastern Telegraph Company, Limited.—This Company notify that the coupons on their five per cent. debentures, due August 1

next, will be paid on and after that date at the banking house of Messrs. Glyn, Mills, Currie and Co., 67, Lombard street, E.C.

Anglo-American Telegraph Company, Limited.—This Company recommend an interim dividend for the quarter ending June 30 of 15s. per cent. on the ordinary and £1. 10s. per cent. on the preferred stock, less income tax, payable on August 1, to the stockholders registered on the Company's books on July 10.

Globe Telegraph and Trust Company.—This Company announce a balance dividend of 4s. per share, making a total of 4½ per cent. for the year ending the 18th inst., carrying forward £2,043.

West India and Panama Telegraph Company.—The traffic receipts of this Company for the half-month ended July 15th were £2,519, as compared with £2,544. The March receipts, estimated at £7,394, realised £7,370.

Eastern Extension Company.—The coupon on the Eastern Extension, Australasia, and China Telegraph six per cent. debentures, due on the 1st of August, will be paid at the Consolidated Bank, 52, Threadneedle-street, E.C. Coupons must be left three clear days for examination.

Edison and Swan United Electric Light Company.—The sixth ordinary general meeting of the shareholders will be held at the Cannon-street Hotel, London, on Tuesday, the 30th inst., at 12 o'clock noon, to transact the ordinary business of the Company. The transfer-books of the Company will be closed from Wednesday, 17th July, to Tuesday, 30th day of July, both days inclusive.

Companies of the Month.—The following electrical companies have been registered during the past month:

Woking Electric Supply Company, Limited, £5 shares.....	£2,000
Electric Trust, Limited, £10 shares	60,000
Northern Electric Wire and Cable Company, £5 shares.....	20,000
Series and General Electric Traction Company, Limited, £1 shares	200,000
Cambridge University and Town Electric Lighting Company, £5 shares	50,000
Chili Telephone Company, Limited, £5 shares.....	250,000
Croydon Electric Supply Company, Limited, £5 shares.....	5,000
Devon and Cornwall Electricity Company, Limited, £5 shares	100,000
Dutton and Company, Limited (Engineers and Electricians), £10 shares	60,000
Kingston-upon-Hull Electric Lighting and Supply Company, Limited, £1 shares.....	1,000
Leicester Electric Light and Power Company, Limited, £10 shares	1,000
Crompton Electric Supply Company of Australia, Limited, £5 shares	50,000
Schoth's Electro Medical Apparatus Company, Limited, £10 shares	10,000
South-Western District and Thames Valley Electricity Company, Limited, £10 shares	100,000
Electricity Supply Company for Spain, Limited, £5 shares	100,000
Municipal Electric Light and Power Company, Limited, £10 shares	25,000
Wolverhampton Electric Light and Power Company, Limited, £10 shares	50,000

NEW COMPANIES REGISTERED.

Westinghouse Electric Company, Limited.—Registered by Norton Rose, Norton and Co., with a capital of £600,000 in £10 shares. Object: to acquire certain patents, goodwill, business, inventions, machinery and property of the American company, known as the Westinghouse Electric Company; to carry on the business of makers and suppliers of and dealers in electricity, electric power and light, to create, produce, store, accumulate, supply, hire, and lease electricity, electric power or other similar agency for any purpose; to acquire all land, estates, factories, personal property, rights and privileges requisite or convenient for the purposes of the company whether from the Westinghouse Electric Company in America or elsewhere. The first subscribers are:

	Pref. Shares.
Sir H. W. Tyler, M.P., Pymms-park, Edmonton	100
F. Parg, Foley House, Portland-place.....	100
J. D. Gibbs, 18, Warwick-street, Regent-street	100
C. C. Macrae, 20, Cheyne-walk, Chelsea	20
W. D'Oyley, 24, Westbourne-terrace, W.....	100
H. T. Norton, 57½, Old Broad-street	10
H. R. Laing, 3, Drapers'-gardens, E.C.....	20

There shall not be less than three nor more than 12 Directors. Qualification, 100 shares. The first are F. Parg, Sir H. Tyler, J. D. Gibbs, G. Westinghouse, jun., and J. Hubbard, the last two not joining the board till after completion of purchase. Remuneration, £2,000 per annum, divisible as they agree.

PROVISIONAL PATENTS, 1889.

JULY 8.

10940. **Improvements in electrical couplings used in electrically lighting railway trains and for other purposes.** Frederick Thomas Hollins, 6, Colville-street, Derby.
10972. **Improvements in and relating to electric gas lighters.** Arthur Edwin Clements, 17 and 18, Southampton-buildings, London.

JULY 9.

11018. **Improvements in and relating to electric railways.** David Gustavus Weems, 45, Southampton-buildings, London. (Complete specification.)
11019. **Improvements in and relating to electric railways.** David Gustavus Weems, 45, Southampton-buildings, London. (Complete specification.)
11032. **Improvements in electric meters, parts of which improvements are applicable to clocks and timepieces.** Joseph Oulton, 232, Otley-road, and Joseph Edmondson, 36, Sunbridge-road, both in Bradford, Yorkshire.
11044. **Improvements in storage batteries.** William Phillips Thompson, 6, Bank-street, Manchester. (Phoebe H. Alexander, United States.) (Complete specification.)
11046. **Improvements in cores for electrical apparatus, and the method of forming the same.** William Phillips Thompson, 6, Lord-street, Liverpool. (The Westinghouse Electric Company, United States.)
11049. **Improvements in dynamo-electric machines, in part applicable to electro-motors.** James John Wood, 55 and 56, Chancery-lane, London.
11054. **Improvements in electric fittings.** Harold Thomson Lyon, 18, Fulham-place, Paddington.
11067. **Improvements in insulation for electric conductors.** Charles Thelismar Snedeker, 4, South-street, Finsbury, London. (Complete specification.)
11070. **Manufacture of elements or plates for secondary batteries.** James Yate Johnson, 47, Lincoln's-inn-fields, London. (Andrew Lawrence Riker, United States.)
11075. **Dynamo-electric machines.** Stanley Charles Cuthbert Currie, 24, Southampton-buildings, London. (Complete specification.)
11082. **Improvement in electric flashing lamps.** Charles Henry Gardner, Frederick Lawrence Rawson, and William Stepney Rawson, 11, Queen Victoria-street, London. (Partly communicated by Percy Scott, H.M.S. "Edinburgh.")

JULY 11.

11179. **An electric meter.** Siemens Bros. and Co., Limited, 23, Southampton-buildings, London. (Firm of Siemens and Halske, Germany.)
11191. **Improvements in roses for supporting electric lamps.** William Arthur Smith Benson, 24, Southampton-buildings, London.

JULY 12.

11215. **Improvements in or appertaining to telephone transmitters.** Joseph Cuthbert Goulding, 6, Lord-street, Liverpool.
11242. **Improvements in dynamo-electric, magneto-electric, and electro-dynamic machines.** Siemens Bros. and Co., Limited, 23, Southampton-buildings, London. (The firm of Siemens and Halske, Germany.)

JULY 13.

11269. **Improvements in electric meters.** Guillaume Arnaud Nussbaum, 29, Ludgate-hill.
11296. **Improvements in appliances for setting up or taking down electric incandescent lamps.** The Hon. Henry Dudley Ryder and Henry Edward Dopson, 24, Southampton-buildings, London.
11300. **Improvements relating to the manufacture of illuminating conductors for electric lamps, and to solutions and apparatus for use in such manufacture.** Henry Harris Lake, 45, Southampton-buildings, London. (Silvanus Frederick van Choate, United States.)

SPECIFICATIONS PUBLISHED.

1888.

11573. **Electric lamps.** Heal and Sanderson, 4d.
15869. **Electro-magnetic induction apparatus.** Harness, 8d.

1889.

4654. **Electric meters.** Canderay, 11d.
6284. **Electric cut-outs.** Prentices, 6d.
7673. **Electric wire insulators.** Heaviside, 6d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.	Name.	Paid.	Price Wednes day!
12 Feb. 1/2	Anglo-American Brush E.L.	—	—
12 Feb. 2/0	— fully paid ..	—	—
14 Nov. 0/4½	Con Telephone & Main ...	1	½
27 July 10/0	India Rubber, G. P. & Tel.	10	19½d.
.....	House-to-House	4½	4½
30 May 2½%	Oriental Telephone	11	½
.....	London Electric Supply ...	5	3½
.....	Swan United	3½	4½
12 July 12/0	Telegraph Construction ...	12	43
2 July 6/0	— 6%, 1889	100	105
29 Nov. ... 5/0	United Telephone	5	15½

NOTES.

Peterborough.—The borough engineer of Peterborough has been instructed to report upon the best means of lighting that city by electricity.

Spanish Exhibition.—A correspondent writes calling attention to the excellent way in which the Spanish Exhibition is electrically lighted by the Gulcher Company.

Electric Shell-Hoist.—A recent application of electric motors for military purposes is that of a shell-hoist, by which the shells or projectiles for cannons are manipulated with the greatest ease by means of a small electric motor and gearing.

Sims-Edison Torpedo.—The *Scientific American* for July 13 has a front-page illustration, with a full description of the electric torpedo invented by W. Scott Sims and T. A. Edison, which those interested in marine defence may like to read.

Utilising Water-Power.—Two waterfalls in Switzerland have recently been utilised for the supply of electricity for the transmission of power—one at Klus on the Aar, by a company at Olten; the other on the Lortze, by a Zurich electric company.

Liverpool Overhead Railway.—It is stated that the contract for the Liverpool Overhead Railway has been let to Mr. J. W. Willans, of Liverpool and Manchester. This important undertaking is the first of the kind in England. The total length is about six miles. The line will be worked by electricity.

India.—We understand that Messrs. Crompton and Co., after having fitted up the telegraph office at Calcutta with the electric light, have submitted important proposals with regard to the lighting of the Port Commissioners' wharves, the Hooghly Bridge, etc., Calcutta, and are also preparing a scheme for lighting the Calcutta *maidan*.

President Carnot at the Exhibition.—President Carnot has been making a careful pilgrimage through the Paris Exhibition, visiting all the principal exhibits. On Wednesday he visited the British section in the machinery gallery, and particularly expressed his interest in the electric ship signal apparatus shown by Messrs. Elliott Bros.

London Chamber of Commerce.—Amongst those who were elected members of the London Chamber of Commerce at the last council meeting, were the Westinghouse Company; James Taylor (Telegraph Manufacturing Company, Limited), telegraph engineer; Richard S. Waring (Waring Cable Company), electric wire and cable manufacturer.

Glass Blowing.—An improvement in the method of using a gas-flame for laboratory glass blowing, proposed by Dr. Lange, may prove useful in incandescent lamp making. This is attained by making part of the air from the bellows pass over a sponge saturated with benzine. The result is a needle-flame of surprising length and very high temperature.

The Paris Syndicate.—We learn that Woodhouse and Rawson, Limited, have just received, as one of the members of the syndicate who have been lighting the Paris Exhibition by electricity, a first distribution of an amount equal to double the sum they originally invested. The syndicate is expected to get back altogether a return of six times the amount invested.

Proposed Electric Tramway to Morecambe.—It is proposed to construct a tramway line from Scotforth, a suburb of Lancaster, through Lancaster to Morecambe, and to work the cars by electricity. The House of Commons has given its consent, but ordered that the speed of the cars should not exceed six miles on the level of the bridge, and four miles on the downward slope at each side.

Electric Police Signals.—The question of extended use of electric signals for the police came before the House of Commons on Tuesday, when the Home Secretary, in answer to a question by Sir A. Rollit, said the electric police-signal system which had been in operation at Islington was now under consideration, and enquiries were being made as to the probable cost of its general adoption.

Tender for Brazilian Cable.—The Brazilian Government has declared lapsed the concession granted to Henry Cumins and others in 1883 to lay a telegraph cable from Ceara (Brazil) to the United States. The Government will invite tenders for the construction of the cable, which will be received at the Rio and Brazilian Legations at Washington, London, and Paris until the 30th of October.

The Jensen Bell Company.—The Jensen Bell Company, with a capital of £80,000, has not floated, only £360 having been subscribed. An action has now been brought against the agents who contracted to float the company, but it has been decided there has been no want of good faith on their part. We intended to remark upon the company if it came before the public, but there does not appear to be any need.

Birmingham Exhibition.—The electrical exhibition at Bingley Hall, Birmingham, work upon which has been very actively progressing, will be opened by Lady Randolph Churchill on Thursday next, August 1, at 12 noon. It is expected to be a great success. Edison has promised he will come, on his way to Paris, if he can possibly get to Europe this year. Further particulars of this exhibition are given in another column.

Telephone Wires and Carriages.—Alderman Wilson, of Sunderland Town Council, and Mr. W. S. Wilson, of the same, seem to have very vague notions about telephony. In a recent discussion, both these gentlemen expressed their opinion that the objection to telephone wires being put underground was that the noise of the carriages passing along the streets made it difficult for people to hear through them!

Backstrom Incandescent Lamp.—The Backstrom incandescent lamp has a filament of carbonised silk: the filament is of high resistance and is run at three watts per candle, the 16-c.p. lamp absorbing 49 watts. In order to prevent the fine filament from being broken by shaking, M. Backstrom mounts a small shank on the interior of the globe parallel to the filament and furnished with an eyelet. The filament passes through this. Vibrations of a sufficient amplitude to break the filament are thus prevented.

Rapid Electric Travelling.—Very successful trial trips are reported of the Weems electro-automatic transit system in Baltimore, U.S., where a two-mile track has been built. This, it will be remembered, is the system proposed for distribution of goods by a light overhead track, and an electric carriage formed like a large shuttle, which it is proposed to shoot along electrically at the speed of two or three hundred miles an hour. A speed of 180 miles an

hour, even round this curved track, is stated to have been attained.

Edinburgh Exhibition.—Considerable progress has been made with the preliminary arrangements for the proposed electrical exhibition in Edinburgh. The various committees are in process of organisation, and the complete list of members will shortly be made known. The Executive Committee is taking the advice of experts in the various departments of which the Exhibition is to be illustrative. The form of guarantee has now been adjusted, and the subscription list will be opened at the next meeting of the committee.

Light Railways in Ireland.—The resolution has been carried in committee at the House of Commons for granting a sum of £600,000 for Irish light railways, and an annual payment of £20,000 on the capital of those railways, the latter being a proviso for working expenses to safeguard the Treasury in case of having to take over any line themselves. Overhead trolley lines and electric tramways are doubtless included in the contemplated extension of Ireland's locomotive facilities, and the already good prospects for electric traction will certainly not suffer by the proposed action.

Cooking by Electricity.—The hotel Bernina, at Samaten, in Switzerland, is situated near a waterfall, which for some time has been utilised to supply light in the hotel. During the long days of summer the light is only required for an insignificant time every day, and the proprietor conceived the idea of employing the force otherwise wasting itself to supply heat for culinary purposes. This has been carried out by a series of resistance wires which are heated to a red heat by the current, and replace the fires hitherto used, with great comfort and convenience, besides saving the fuel.

Safety Insulating Staple.—Messrs. Mosses and Mitchell inform us that they have been appointed sole agents for the safety insulating staple, which, instead of being made of iron wire and liable to cut the insulation or destroy it by rust, is itself made of a hard insulating material, and aids rather than deteriorates the insulation of the wire. The staples are made in various sizes to suit all kinds of electric wires and cables, and will, no doubt, prove very useful in house installations for electric light, as well as for bells, telephones, and telegraph wires, especially in places liable to moisture.

Electric Tramways in Australia.—The Sandhurst and Eaglehawk Electric Tramway Company, Limited, formed for the purpose of putting down a tramway and working it electrically, have entrusted the work to Messrs. Booth, Ellson, and Co., electrical engineers, of Melbourne, who have placed the order for the plant for the charging station with the Anglo-American Brush Electric Light Corporation, Limited, who will also supply the cars, motors, and accumulators. It is expected that the first section of the work—a line five miles in length—will very shortly be in operation.

Exeter Theatre.—The re-erection of the Exeter Theatre, under the direction of Messrs. Darbyshire and Smith, is progressing satisfactorily, and there is every prospect that the contractors (Messrs. Dart and Son) will finish their work early in September. It has been decided to light the whole of the stage and its adjuncts by electric light, for which arrangements have been made with the Exeter Electric Lighting Company, who are also entrusted

with the lighting of the auditorium and principal saloons. Gas will be used as an alternative and a safeguard in the orchestra, at the back of the amphitheatre, and in the passages and staircases.

Electric Temperature Indicator.—An ingenious modification of the thermometer has been devised by MM. Morin and Berthélemy for indication of temperature at a distance. In this the variations of the height of the column of mercury are utilised to modify the resistance of a circuit which may extend to any convenient length, and is connected to a battery of sensibly constant E.M.F. A very thin platinum wire is introduced in the tube of the thermometer, and the rise and fall of the mercury is thus at once indicated by the indications of a galvanometer at any desired spot. The apparatus is made by M. Berthélemy, instrument-maker, and is exhibited at the Paris Exhibition.

Safety Device for Alternating Currents.—Messrs. Drake and Gorham inform us that they have made a long series of experiments with the safety device for high-tension alternating currents, the patents for which they purchased from Captain Cardew. They have found it reliable under all conditions, and a number have been supplied to the London Electric Supply Company for use on their supply station. The apparatus was recently shown at the conversazione at Finsbury College, and described by us at the time; it is an ingenious application of the static attraction due to high-tension currents. We hope shortly to give an illustration of the apparatus as now manufactured.

French Accumulator Company.—A company entitled the Société Française d'Accumulateurs Electriques (Faure-Sellon-Volckmar) has been formed in Paris by Messrs. Philippart Bros. for the manufacture, exploitation, and development of the secondary battery. The address of the new society is 181, Rue de la Pompe, and the capital is fixed at 1,100,000f., with power to increase to 2,000,000f. The company take over the patents of Faure, Sellon and Volckmar, and Philippart. The first directors are MM. Gilbert Le Guay, senator; Adolphe Klingelhöfer, landowner; Martin Rée, merchant; Bernard Lœwenstein, banker, of Brussels; Edouard Limauge, late broker at Brussels.

Engines and Boilers.—Messrs. Davey, Paxman, and Co., of Colchester, have sent us a copy of their general catalogue of engines and boilers for 1889. In this are some imposing illustrations showing the arrangement of several of their principal large installations of engine and boiler power, viz., for the Colonial Exhibition, for the Royal Agricultural Show at Newcastle, and at Paris the immense plant for the distribution of compressed air for prime movers. The catalogue contains illustrations and descriptions of portable, semi-portable, and stationary engines for all manner of requirements, as well as boilers and pumps. Those who require thoroughly high-class driving plant cannot do better than obtain and examine Messrs. Paxman's catalogue.

A New Photometer.—Electrical engineers constantly feel the need of a photometer which shall not depend upon the comparison of two lights or shadows by the eye, and shall thus eliminate the personal error in photometry. A new principle for an instrument of this kind is proposed by Dr. Deessendier, who has devised an arrangement in which a mixture of chlorine and hydrogen is exposed to a source of light in such a manner that explosion does not

occur, but a gradual combination and absorption of the hydrochloric acid by a solution of chlorine, the level of the solution rising in proportion to the intensity of the light. With proper safety appliances to prevent explosion an instrument of this kind might solve the difficulty of the accurate measurements of the candle-power of lamps.

Paris Railway Stations.—The Gare Saint Lazare, at Paris, has been lighted by electric light. There are 100 lamps of 10 and 16 c.p., 153 arcs of 400 c.p., and 18 arcs of 250 c.p. The plant consists of three Belleville boilers, three engines by Lecouteux and Garnier, and six Gramme dynamos of 450 amperes and 100 volts. Two sets suffice for the lighting, the third being for reserve. The installation has been carried out by the Société d'Appareillage et d'Eclairage Electrique, who maintain the light at charges of ½d. an hour for the incandescents, and 3d. and 4d. an hour respectively for the arc lamps. The contract is for 10 years, after which period the whole installation becomes the property of the railway company. The lighting is regular and very satisfactory, and a brilliant illumination comparable to the light in full day is obtained in the station.

Slow Goods Traffic.—Whatever objections might be raised by timid people to the introduction of quickly-moving electrically-propelled appliances on the streets of London, such as for omnibuses or cabs, one cannot but be struck with the field of usefulness for a slow-speed electric van on seeing the large and heavy goods vans owned by the railway companies, slowly drawn along by four immense horses. Here, if anywhere, is great scope for the electric van, and the speed, not being great, would give complete control over the vehicle. The application of the idea of Mr. Radcliffe Ward's omnibus to good's-vans has been under contemplation by the railway companies, and, while electric tramways and telfer lines multiply, we may possibly soon see the employment in commercial life of electric vehicles without rails commending itself to railway companies for the slow goods traffic in towns.

Electric Light Fittings at the Cafe Frascati.—The Café Frascati, Oxford-street, has been handsomely fitted by electric light, the fittings being manufactured by Benham and Froud, Limited. The principal public dining-rooms are lighted by a number of handsome combination electroliers, designed in Renaissance style, some for 13 and others for 17 lamps, made of polished brass with hand-wrought leaves and cusps, the incandescent lamps burning within ruby and other art coloured glasses, also specially designed. The buffet is similarly lighted, with the addition of 5-light pillars on the counters. The grillrooms and private dining-rooms have a large number of electroliers, for three or four lamps each, in harmony with the above, and similarly wrought. The grand staircase, corridors, etc., are lighted by combination gas and electric brackets, and by a number of single brackets, with hammered leaves and finely-chased wall plates.

Maidstone.—The Maidstone Gas Company has refused to accede to the petition of the local authorities to reduce the price of their gas for public lighting, and consequently the Local Board have appointed a committee to consider the proposals of the Municipal Electric Light and Power Corporation, the Electric Construction and Maintenance Company, and the South of England House-to-House Electricity Company, who have given notice of intended application to the Board of Trade for provisional orders sanctioning the supply of electricity in Maidstone, under

the Electric Lighting Acts of 1882 and 1888. Some time ago a company was formed for the lighting of Maidstone by electricity, but the Local Board obtained an order for the deposit of £500 before any of the roads should be broken up, and nothing more was heard of the project. It remains to be seen whether the committee will recommend the insistence of the companies now applying to deposit this sum.

Accident at Barking-Road.—A very peculiar accident occurred to one of the accumulator cars on the Barking-road route on Monday evening last. A defective driving switch on one of the cars short-circuited the battery of accumulators (100 volts) just as the driver, after putting down the passengers at Green Gate, Plaistow, was taking the car on to the stand previous to leaving for Canning Town. The instantaneous combustion of the insulation of the cable and evolution of gases from the passage of so great a current produced an explosion of considerable power, which lifted the seats and shattered the glass of all the windows on each side of the car. No damage was done to the electrical equipment save the destruction of the insulation of 20ft. of cable, as it is protected by suitable cut-outs. An additional one has now been put in each car, which will prevent any possible excess of current. The only injury was that to a lad, whose face was cut by some of the pieces of glass.

New Lubricator and Oil Filter.—Messrs. Woodhouse and Rawson are introducing a new sight-feed lubricator and a new oil filter, specially for use in electric installations. The first is Fairbairn's patent and possesses all the advantages of other sight-feed lubricators without the disadvantage of fixing to a steam-pipe. An adjustment screw allows any desired number of drops of oil per minute to float up through water contained in a glass, the oil flowing off from the top of the water down a small metal tube to the part to be lubricated. The Diamond oil filter combines a handy method of dealing with refuse oil, combining in a single case a quadruple cleansing apparatus of compressed, clean, new cotton twist, white unbleached. This requires renewing only five or six times a year, and can be done by any ordinary mechanic. The filter is self-acting, and adjustable to a stated quantity of oil. It seems useful, and we are informed that enquiries are rapidly coming in for the supply.

Alnwick Castle.—We still continue to hear of the rapid spread of electric lighting in country houses, and it is now becoming as general for architects to consider the question of electric lighting as to arrange for the heating or ventilation. The Duke of Northumberland, who was amongst the early experimenters with electric light, and, in fact, made use of some of the earliest productions of Mr. J. W. Swan, has decided to light Alnwick Castle as far as possible with his available water-power, which may be taken at 20 to 25 h.p. The engineering of this installation has been entrusted to Messrs. Drake and Gorham, who, it will be remembered, recently carried out similar work at Craggside for Lord Armstrong. The water-power is to be derived from the Abbey Mills, in the vicinity of which the dynamos will be placed, and from this point the mains will be taken across the grounds to a battery-chamber in the Falconer's Tower. The drawing-room, library, ante-room, billiard-room, and music-room are the apartments at present intended to be lighted.

Exeter.—In their first annual report the directors of the Electric Lighting Company at Exeter state that the

scheme originally contemplated of using water-power at Trew's Weir was abandoned owing to objections by the Town Council, and that the freehold property adjoining the London and South-Western Railway, known as Rockfield Factory, was acquired at a very low price, and plant of the highest efficiency is now being laid down. The demand for the light has exceeded their expectations, and a large number of arc lamps and about 1,000 incandescents have already been applied for. Several public buildings, churches and chapels, and hotels have decided to introduce the light. Further capital will be required, and 500 shares of £10 of the unissued capital are offered for subscription. The share capital already subscribed, including shares agreed to be taken, is £7,000. The directors look forward to an extending and paying business, and we are pleased to see the promising start that has been made in central station work in this town.

Government Standardising Laboratory.—The Board of Trade desires to avail itself of the organisation of the London Chamber of Commerce for the purpose of ascertaining the probable extent to which a Government laboratory for standardising electrical instruments would be used—(a) by supply companies for the certification of meters, voltmeters, and ammeters, and (b) by manufacturers of electrical instruments. The London Chamber of Commerce have therefore addressed a circular to persons interested, asking for replies to the following questions: 1. Supposing a standardising laboratory to be ready at the commencement of the year 1890, how many ordinary house-meters do you expect to send in for certification? 2. How many ammeters do you expect to send in? 3. How many voltmeters do you expect to send in? 4. State whether you send in as an undertaker or as a manufacturer? The answers are to apply for the years 1890 and 1891. The individual replies will be considered as confidential, and only the aggregates will be published.

The Electric Motor to the Rescue.—A good illustration of the advantage of having a source of power at hand in the electric mains, and of the usefulness of the electric motor in an emergency, is furnished by the following incident in newspaper work: The *Washington Evening Star* recently had its boilers, engines, shafting, belting, and even the engine-room hopelessly wrecked by the wall of the press-room collapsing, and it was feared it would be unable to procure power, and therefore would of necessity be obliged to suspend publication for repairs. As the presses were intact, however, it was suggested that electric motors might be utilised. These were telegraphed for, three 15 h.p. motors were sent, and as soon as they could be set up and connected to the electric light mains the presses were ready to toss off their thousands of copies as if nothing had happened. The C. and C. Company, of New York, whose motors were used, have received a suitable acknowledgment from the publishers of the paper for the energy displayed in relieving them in their difficulty, and also for the excellent service rendered by the motors.

Lambeth Vestry.—At the meeting on July 18 the clerk read letters from the Metropolitan Electric Supply Company, the London Electric Supply Corporation, the Electric Construction and Maintenance Company, and the House-to-House Electric Supply Company, giving notice of their intention to apply to the Board of Trade for provisional orders to supply electricity within the parish. The clerk explained to the Vestry that at present two orders

had been obtained, one by the Metropolitan Company, and the other by the London Electric Supply Corporation. The former had entirely withdrawn their order, and the streets included in the latter were only three—viz., Westminster-bridge-road, New-cut, and Lower-marsh—and the representatives of the company declined to take any further responsibility. The question which the Vestry had to consider was whether the compulsory area was a sufficiently large one, and whether they should not endeavour before committee to obtain the insertion in the order of further streets. He suggested that the matter should be referred to the Electric Lighting Committee, with power to present a petition against the London Company's order, if they thought fit and proper to do so. The suggestion was unanimously agreed to.

Railway Working by Electricity.—Mr. Leo Daft, in his recent experiments with his 100 h.p. locomotive on the elevated railway in New York, finds that the electric engine can exert some 30 per cent. great tractive force on the rails, and thus correspondingly increase the available carrying power. This he still is inclined to attribute to some extent to the increased grip of the wheels where electricity passes into the metals, but he also points out that the steady and continuous pull of the electromotors, instead of the intermittent action of the piston in steam engines, may have something to do with the increased power in haulage. That the electric engine is in a fair way to become adopted on suburban ordinary railways must be increasingly felt as the result of these experiments become more widely known. The introduction of electric power on both elevated or underground railways is eagerly looked forward to by those engineers who appreciate its possibilities, and it is to be hoped that the proposal now before the Metropolitan Railway Company to make a trial, without cost to the company, of the direct system on that line, will result in the proof to English railway directors of the practicability of electric engines for their purposes.

Sixty Electric Cars for Cleveland.—There are very few towns, even in the States, where the advantages of electric traction are more fully recognised than at Cleveland. It is only nine months since electric cars were first introduced, and the system has taken its place as the recognised method of suburban traffic. Fresh cars are constantly being added, and a new extension of the East Cleveland Electric Railway has just been opened. It is the intention of the East Cleveland Company to run 60 motor cars on this line on a two and a half minutes' service, and all horses will be removed from the line as soon as the motor cars are equipped with the Sprague motors which have been ordered. It is said that the experiment will be made of running these cars at the rate of about 11 miles an hour through the city, and it is not thought that the City Council will object to this, since it is maintained that electric cars run at this speed are much safer to the general public than horse-cars run at only six miles an hour, as the electric cars can be stopped very much more quickly than those drawn by animal power. The electric cars are extremely popular with the passengers and property owners along the line, and in the recent public meeting proposing the extension the resolutions were adopted unanimously by a large meeting of citizens.

"Electrical Distribution."—A very handsomely-got-up pamphlet upon the subject of electrical distribution has been issued by the United Electrical Engineering

Company. It is intended to give proposing users a general review of the question of electric supply both for light and for power, looked at from their own point of view, and contains a good deal of information of the kind naturally enquired after by intending purchasers. There are illustrations of the Statter alternate-current dynamo and transformers, the constant-current dynamo for municipal series lighting, motors, traction, etc., with arc lamps, hoisting gear, and posts. Considerable attention is given to the department of electric motors, and the advantages to all industrial trades is pointed out. Information as to the cost of a supply station forms one of the features, and figures are given at rates which the company are prepared to undertake contracts. Some remarks upon how to establish a local electric supply station are specially applicable at the present moment, when numerous corporations are enquiring as to the possibility of adopting the light, and not the least suggestive part of the pamphlet to a person investigating the merits of electric light is the dictum of the *Gas and Water Review* that "It is no use blinking the matter—the electric light is steadily gaining ground." The United Electrical Engineering Company are laying themselves out for good work, and are evidently prepared to do their share in the development of electrical distribution.

To Paris in Two Hours.—The wonderful "Water Railway," described last Monday by the *Daily News*, as exhibited in Paris, although looking very much like a flight of fancy, may, if it be found at all practicable, prove a neck-and-neck competitor with the electric railway for high-speed railways. This extraordinary invention has a carriage without wheels, sliding upon a grooved iron rail. Water at high pressure is forced under the slide blocks; this raises the carriage slightly, and distributes itself in a finely-divided state under the block, reducing the friction practically to nothing, so that the carriage may be moved by the pressure of the forefinger. High-pressure water taps, distributed along the permanent way, are directed against a rack under the carriages, and force the train along at a speed, it is alleged, of 80 to 120 miles an hour, and the chairman of the company owning the invention contemplates a journey from London to Paris (when the Channel Tunnel is completed) in two hours. High-speed traction is in the air, and various schemes are afloat to still further annihilate distance, an essential part of such schemes being the use of stationary engines at points along the line. The scheme of this kind which uses electricity as the propelling force has, it appears, already a week or two ago been practically tried in America, where enormous speeds, three or four times that of our express trains, are mentioned. While mechanical difficulties of apparently insurmountable nature seem to arise at the suggestion of such speeds, there are not wanting engineers who believe in the possibility of both these undertakings, and great interest must attach to the experiments, which may lead to the development of railways working at speeds almost undreamt of, except in the scientific romances of the present day.

Provisional Orders Bill.—In the House of Commons on Friday, July 19, the motion was brought forward to read the Electric Lighting Provisional Orders Bill for the third time. Sir G. Campbell asked whether the Corporation of Birmingham had given their consent to the provisional order relating to the city in an express and direct form. He suspected that the Board of Trade were going too far

in letting loose electric lighting companies all over the country, and he did not think that they had sufficiently complied with the spirit of the law, which required that the consent of the local authorities should be obtained before any provisional orders were granted. Sir M. Hicks-Beach entirely repudiated the policy which the hon. member attributed to the Board of Trade of disregarding the wishes of the local authorities in this matter. On the contrary he thought that the greatest importance should be attached to the desires of the local authority. It was not only the obvious intention of Parliament that that should be done; but it was the proper and right policy to pursue. He might say that only this Session he had over-ruled a report made by an officer of the Board of Trade in favour of a provisional order in a very important case, because the consent of the local authority had been refused. The Corporation of Birmingham, as the hon. gentleman had stated, were able to take care of themselves. They were represented by as many as nine members in that House, and this Bill had passed through all its stages without a word of objection from any one of them. More than that, communications had passed between the Board of Trade and the Birmingham Corporation which showed ample evidence of the fact that the Corporation were consenting parties to the Bill. He admitted that they had not in so many words recorded their assent; but they had intimated their willingness to do so; and it would no doubt be received at the Board of Trade by the next day's post. The Bill was then read a third time.

Visual Police Signals.—A system of inter-communication between the police on duty and district police-stations or the chief office has been invented by Messrs Brewer and Smith, of the United States. It is being introduced into this country by Mr. Otto Friederici, of 76, Finsbury-pavement, London. It consists of a lamp-post surmounted by an ordinary gas lamp, but having a small cast-iron box about 4ft. from the ground, which box contains a complete set of signal, call, and telephone apparatus. This arrangement, it is said, can be attached to any ordinary lamppost. In carrying out this system a lamp-post is fixed in a prominent position on every beat, and is placed in electrical connexion with the necessary police-stations and the head office. In the event of a policeman's requiring assistance from a man on the next beat he opens the box with a private key and touches a lever, which causes a red glass globe to rise and enclose the gas burner. This forms alike the day and night visual signal. If the policeman desires to communicate with the district police-station or with the head office he signals by an electrical call bell, and on being answered he communicates further by telephone. At the chief office and at every station there is a call board, by which it is at once seen whence the call proceeds. The attention of a policeman on any beat can be attracted by those at the chief office or at the stations, who can cause the red globe to be raised. Upon seeing this signal the policeman can go to the box, ring the electric bell, and thereafter proceed to communicate through the telephone. It is also proposed to add a series of automatic signals to each post, and to give householders the means of signalling for assistance by this means. The advantages of the proposed means of rapid inter-communication are obvious, while it is held that it would obviate the necessity for increasing the police force. It is stated that the system is in use in the United States, and that it is now under the consideration of the Secretary of State, having been inspected by a committee appointed by the Commissioners of Police.

A VISIT TO "MR. BROOKS, OF PHILADELPHIA."

(FROM OUR SPECIAL CORRESPONDENT.)

In response to a cordial invitation from genial Mr. David Brooks, of underground-wire fame, I made a trip to the Quaker City a few days back in order to see the Brooks system at work in its birthplace. A two hours' run on the Pennsylvania Railroad landed me in the second city of the United States, and passing through the barrier the expansive countenance and still more expansive shirt-front of Mr. Brooks were in full evidence before me. Mr. Brooks was accompanied by Mr. George H. Bliss, a well-known electrician, of Chicago, who is about to introduce the Brooks system into that city of underground wires *par excellence*.

Our first visit was paid to the offices of Messrs. Peter Wright and Co., in Walnut-street, where we were introduced to Mr. Brooks's colleagues, both, like himself and Mr. Bliss, old-time telegraph men, and telegraph reminiscences were the order of the day. Comparisons were made between the plethora of electrical construction companies of the present time and the period when some of these gentlemen set out to build the first telegraph line in Mexico, when the necessary materials could not be bought ready-made, but everything—wire, insulators, instruments, and tools—had to be made to order. Our next visit was to the offices of the Pennsylvania Railroad Company, occupying a magnificent building in the centre of the city. Mr. Brooks then piloted us to his laboratory, which contains appliances of all sorts for testing the oils used in the Brooks system, and also a complete set of testing instruments, which bear the well-known names of Elliott Bros. and the Silvertown Company, used for determining the insulation resistance of the conductors. The laboratory is also well supplied with copies of all the English electrical journals. A test was made of a double coil of cotton-covered wire which had been for some time immersed in a can of resinous oil, with the two lower ends exposed to the liquid. The total dielectric resistance was found to be 7,000 megohms.

We next paid a visit to the Edison Central Station, "a pile immense, cyclopean, with boilers huge and much machinery!" as a spasmodic little circular which I picked up in the office so poetically states. This station is one of the largest in the United States, and has proved a great success. It runs night and day, seven days a week.

Mr. Brooks then conducted us to the Union League Club, and regaled us with a sumptuous lunch. The League is a magnificent building, and is lighted throughout by electric light.

Having fortified the inner man, we once more set forth to brave the burning sun of Philadelphia. The glass was at 90deg. inside the League, so whereabouts it had climbed to outside I leave the reader to imagine. Passing through the enormous public buildings, a massive granite pile of superb architectural beauty, in which, upon its completion, all the public departments of the city are to be installed, we made for the terminus of the Pennsylvania Railroad, and were admitted to the battery-room of the telegraph department where the wires installed by Mr. Brooks are terminated. These wires are 53 in number; they are contained in a 2in. iron tube. The wires are protected by a textile covering, and made up into a cable, with hemp sheathing; this cable is saturated, and the pipe is filled with a mixture of resin and resin oil. The cable connects the Broad-street Station of the Pennsylvania Railroad with the Powelton-avenue Station, distant about one and one-third miles. The wires are terminated by means of a splice-box, in which are inserted two curved arms, shaped like the lower part of the letter U. These arms are filled with solid resin, to prevent the oil escaping. The wires, upon emerging from the arms, are protected by a lead covering, a few inches of which, together with the insulation, are cut out near the ends of the wires, and pieces of indiarubber tubing are slipped over and bound tightly with twine at each extremity, which simple device proves an effective remedy, or rather preventive, against leakage from the terminals through the lead covering.

This installation was carried out about two years ago,

under Mr. Brooks's personal supervision, by workmen who had had no previous experience in electrical work of any sort. About two-thirds of the pipe is suspended in the braces of the elevated railway structure; the balance is laid in a ditch and covered by running water. Although so much of the pipe is exposed to the sun's rays, the joints show no signs of strain from contraction and expansion, and there is no appreciable amount of leakage of the insulating mixture. The whole length of pipe is examined monthly, and so far neither it nor the cable shows any signs of wear or abrasion from the jar of passing trains and the vibrations of the structure. As regards electrical tests the most satisfactory results have been obtained. A test taken by Prof. Kendall, of the Pennsylvania University, about a year ago showed an average insulation per mile of the whole 53 wires of 4,102 megohms, and an average electro-static capacity of .2233 of a microfarad per mile, the observed temperature being 50deg. Fahr. A later test, taken in December, 1888, when the temperature of the air was 25deg. Fahr., gave, of course, much higher results.

All the wires had been used in connection with overhead lines along the railway for over a year. The four conductors which had carried the heaviest currents during the period of service were selected for examination. Two of these had been in connection with dynamo currents in New York. One went to Pittsburg, the other to Washington. The results obtained were—highest insulation, resistance per mile, 16,913 megohms; lowest ditto, 8,258 megohms. The average electro-static capacity per mile was .15 of a microfarad. Naturally the extremely low temperature (25deg. Fahr., as stated above) influenced a good deal in the production of such very favourable figures, but even making due allowance for difference of temperature, the electrical properties of the Brooks system are of a very high standard of excellence. The wires are used both for telephone and telegraph circuits, and two are employed in phonoplex working. Those who use telephone circuits report that speaking is more distinct than when the telephone wires were in a special cable used for telephone circuits only, and that, although the signals of the telegraph are heard, articulation is much plainer than before. A curious fact also is that the influence of the phonoplex circuits upon the wires in the cable is much less marked than is the case with the overhead wires beyond, where the phonoplex lines are on special poles, and separated from the rest by the entire width of the four-way track. It is interesting to know that during the two years that the cable has been at work no fault has ever developed in any of the 53 wires; neither has any interference to working been caused by atmospherical electricity. A word as to the economy of the Brooks system. Mr. Brooks figures out the cost of laying a 100-wire lead-incased telephone cable, protected by an iron pipe, at \$45.95 per mile for each conductor. By his system, he puts 225 conductors in the same size of iron pipe, and the cost per mile per wire is \$21.72, or less than half.

Having bewildered our brains and filled our note-books with all these interesting data, we take a stroll along the road underneath the railway structure in order to examine the pipe and splice-boxes. During this investigation an accident nearly happened to Mr. Brooks which might have proved an unpleasant termination to the day's proceedings. Owing to the noise of a train passing overhead, we none of us heard a trotting horse approaching on our side of the road at a 2.30 gait. Mr. Brooks was just about to step off the pavement right in front of the horse, but, receiving timely warning from a passing carter, was enabled to balance himself on his stick. The trotter flashed past, and a serious accident was averted by a mere hair's breadth.

Having concluded our inspection of the cable, and being thoroughly satisfied that it was all "OK" in every respect, we returned to the comparative coolness of the Union League, and there enjoyed a well-earned rest. After a chat over matters electrical, we dispersed on our several ways, each one of us carrying the conviction that for high electrical properties, economy and convenience in construction and laying, it would be hard to beat the Brooks system of underground conductors.

DIAMAGNETISM.

BY S. E. PHILLIPS, F.C.S.

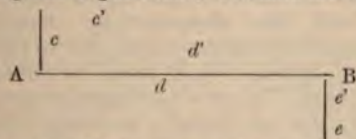
(Concluded from page 48.)

Tyndall's third memoir is "On the Polarity of Bismuth, and an Examination of the Magnetic Field." This section is curious, complex, and difficult to understand. In 1847, Prof. Poggendorff maintained that in a transverse bar of bismuth, between two poles, that side which faced the N pole possessed N polarity, and the side facing a S pole had S polarity.

Tyndall, in various ways, demolishes this contention, but I fail to clearly grasp the many complexities. He deems it necessary that some material imagery should be resorted to in aid of an intelligible conception of the phenomena. "Thus we have the magnetic fluids of Poisson and the lines of force of Faraday, or Sir William Thomson's imaginary magnetic matter, differently distributed in the two cases; or Reich's two kinds of magnetic matter," or Poggendorff's transverse "opposite, opposite polarity" for bismuth, or Weber's diamagnetic molecules, surrounded by channels in which the induced currents are excited, and flow without resistance (p. 171), etc.

Now, among this delectable selection of wanton assumptions, I believe that Faraday's fertile idea of "lines of force" is almost exclusively followed by practical electricians, and it is unfortunate that Tyndall should prefer a more devious course.

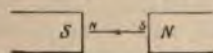
The idea of a compound or resultant disposition of the lines of force in a field such as we have referred to in illustration of his great experiment, is somewhat thus:



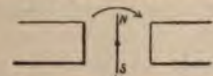
where in a simple field, between the two poles, A, B, the intensities may be represented by c, d, e , where d is an unstable position for an iron sphere, and a stable one for bismuth, but that subject to a disturbing coil effect the intensities may become $c' d' e'$, the central point, etc., being removed to d .

Now Tyndall had a cleverly contrived apparatus for mapping out the intensities of a complex field, and one of two things. He is either guided by actual trial and fact in thus picturing a deflection of this central point, d , or he is led by assumptions like those of Poisson, Thomson, Weber, and others, as inherent to his complex imagery of a magnetic field.

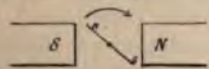
Under such circumstances it is a bold step to suggest the latter alternative, but let us fairly examine the conditions. We, first of all, have a simple or symmetrical field, whose character may be indicated by a suspended iron bar—thus:



Next we have a right-handed coil, the current going from left to right in the upper half, thus:



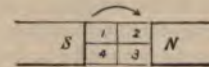
And lastly we have the two combined, whence the problem is simply a parallelogram of forces; and, assuming the two right-angle forces to be about equal, the resultant distribution of the lines of force must be midway between the two, or at an angle of 45deg.



It is therefore evident that with a weak magnet and a strong coil the lines of force would only be deflected a few degrees from the perpendicular, while, if the magnet be strong and the coil weak, the lines of force would only be deflected a few degrees from the horizontal. Hence I do not like Tyndall's representation, which is only strictly true when the forces are about equal. He says:

"From these facts we learn that if a magnetic field be divided into four compartments, the current in the upper

half being as represented by the arrow, that the force in the first and third quadrants will be strengthened; but will be weakened in two and four."



Of course, iron would take the position in one and three, and bismuth in two and four. "With the aid of this simple fact we can solve every experiment made with bismuth bars."

Now, is not this precisely the way in which I solved his great experiment? and is there anything in all this which corresponds with the Tyndall analysis of the field in Fig. 1. I do not know, and I may well hesitate in face of such an authority, but it does seem to me that his assumption of the varied intensities and a corresponding change of the d point is nowhere; and that between these experiments and the one referred to, the only effective difference is in having a short bar, with a wider coil space, instead of a narrow coil and a long bar.

It does seem to me that in all three cases the (d) point would be alike central.

"On a Differential Medium and Letter to Faraday." Nature abounds with antitheses, one of which we have referred to, but whether the law of the squares be valid up to the point of saturation, or only approximatively so, as we have maintained, is quite immaterial to the present line of argument. In either case there is a line of demarcation between antithetical conditions.

Now to overlook this distinction, and to apply reasoning which may be valid on one side, to the other, is clearly unsound; yet if we mistake not this is the weak point of Tyndall's final appeal in a letter to Faraday at the end of the book. This letter does him infinite credit, as furnishing such a fair, candid, and respectful statement of Faraday's final contention. But with his accustomed ability and clearness of expression, he raises a point which is regarded as adverse to Faraday's view. In the art of disputation, it is far too common a practice to misrepresent an opponent, but deeming this letter such a model of procedure, I am tempted to quote somewhat fully. He says: "In support and illustration of your views you appeal to the following beautiful experiments: 3 solutions of proto-sulphate of iron are taken; the 1st (l) contains 4 grains, the 2nd (m) 8 grains, and the 3rd (n) 16 grains to a cubic inch of water. You then find that when a tube containing a solution of a certain strength is suspended in a weaker solution between the poles of a magnet, the tube sets from pole to pole, and that when the solution without the tube is stronger than that within it, the tube recedes from the poles and sets equatorially. Here, then, you state, are the phenomena of diamagnetism."

"It is maintained by some that to account for these facts it is necessary to assume, in the case of diamagnetic bodies, the existence of a polarity the reverse of that of iron. But nobody will affirm that the mere fact of its being suspended in a stronger solution reverses the polarity of a magnetic liquid. To account for the repulsion of the weak solution when submerged in a stronger one no such hypothesis is needed. Why, then, should it be necessary in the case of so-called diamagnetism?"

"It is only by denying that space holds a medium which bears the same relation to diamagnetic bodies that the stronger solution bears to the weaker one, that the hypothesis of a distinct diamagnetic polarity is at all rendered necessary. The effects are differential ones, and are embraced as already observed by E. Becquerel, by the so-called principle of Archimedes. This principle affirms that the body immersed in the liquid is attracted by a force equal to the difference of the attractions exerted upon the liquid and the body immersed in it. Hence, if the attraction of the liquid be less than that of the immersed body, the latter will approach the pole. If the former attraction be the greater, the immersed body recedes from the pole, and is apparently repelled."

"The action is the same as that of gravity upon a body plunged in water: if attracted more forcibly, bulk for bulk, than the water, it sinks; if less forcibly attracted it rises, the mechanical effect being the same as if it were repelled by the earth."

"The question, then, is, Are all magnetic phenomena the result of a differential action of this kind?"

"Does space contain a medium less strongly attracted than soft iron and more strongly attracted than bismuth (it might be simpler to ask if the air be more conductive than bismuth) thus permitting the approach of the former, but causing the latter to recede from the pole of a magnet. If such a medium exists, then diamagnetism, as you incline to believe, merges into ordinary magnetism, and the polarity of the magnetic force in iron and bismuth is one and the same.

"Pondering upon this subject, it has occurred to me to push this idea of a medium to its necessary 'consequences.'" Here I must abbreviate: Given a cube formed of the dust of carbonate of iron which has been compressed in one direction, then we may place this cube upon a torsion beam, so that the lines of compression are at right angles to the lines of force, where its attraction can be accurately measured. We now place the cube so that the lines of compression may coincide with the lines of force, and we find a greater attraction. We may now imagine other cubes of weaker magnetism, approaching that of the air in which they are suspended, and given one where the second position was found to be equal in that of the medium, it would be indifferent, but on placing it in the first position with the lines of compression at right angles to the lines of force, it would be repelled as a diamagnet. Next, if the magnetism of the cube be further diminished, it would act as a diamagnet in both positions, but the line of compression would approach nearer to the magnetic weight of the medium, and would evince less repulsion than when the force acts across that line."

Here, then, Tyndall makes a great mistake, and the emphasis is his. He has passed the line into an antithetic region, and reasons as if unconscious of the fact. He well knows that such a cube would not approach the magnetic weight of air, but *would recede from it*; but he tries to fasten upon Faraday a dilemma of mistake which is purely his own. As compression intensifies that state or condition of matter which we call magnetic, so having passed the line into an antithetic region, proximity of particles intensifies that state or condition of matter which we call a diamagnet.

It is no dilemma of Faradays, but simply the expression of an opinion, that such ought to be the case, under the predominance of a differential medium.

It is like saying that because magnetic attraction has increased up to a certain point, that such ought to take place with a magnetic needle, whereas we know that having passed a certain point into an antithetical region, a totally different law of increase subsists. Whatever difference of opinion there may be on this subject in the light of theory, the facts are clear and plain, which indicate an antithesis of conditions of laws and of properties in the two cases.

Referring to M. Weber's experiments, Tyndall observes "that neither his labours, nor those of Poggendorff and Plucker, produced conviction in the mind of Faraday. The notion of a distinct polarity for diamagnetism was also opposed by others. Prof. von Feilitzsch, for example, contended on theoretic grounds, and backed his contention by definite experiments, that the magnetic excitement of bismuth and iron were the same. This was also the view of E. Becquerel, and Mattenci subsequently entered the field as an ardent opponent of diamagnetic polarity."

Quite recently two eminent physicists have submitted to the Paris Academy of Sciences papers in favour of the views now submitted for reconsideration in England.

ELECTROLYSIS OF BISMUTH SALTS.

BY ALEXANDER WATT.

(Concluded from page 46.)

24. *Double Cyanide of Bismuth and Potassium.*—A solution was prepared by precipitating sulphate of bismuth with one of cyanide of potassium, and redissolving the precipitate with excess of the cyanide. With the current from 2 cells, a bright film of bismuth was deposited on a brass plate, but the action was, however, rather slow.

25. An attempt was made to determine whether cyanide of potassium in solution would act upon a bismuth anode by electrolysis, for which purpose a strong solution of the cyanide was prepared, in which was placed a bismuth anode and a brass cathode. The current from two Daniells was used, and after a few seconds' immersion of the plates the anode became discoloured, gradually acquiring a brown colour, while the cathode became coated with a greenish film. There was no metallic deposit.

26. *Bismuth Phosphate in Caustic Potassa.*—A solution of nitrate of bismuth was precipitated by one of phosphate of soda, and the precipitate digested in a strong solution of potash, in which the phosphate was very sparingly soluble. The solution thus obtained was afterwards diluted with water, and electrolysed with the current from three cells. A bright deposit of bismuth slowly formed on a clean brass plate, and there was no tendency to the formation of spongy metal.

27. *Phosphate of Bismuth in Cyanide of Potassium.*—A bath was formed by dissolving the recently precipitated phosphate of bismuth in a strong solution of cyanide of potassium, and the liquid, after being allowed to settle, was decanted and worked with the current from three cells, when a bright film of bismuth at once formed upon a brass plate, and retained its reguline character during a long immersion. The metal adhered firmly to the brass surface.

28. *Tartrate of Bismuth.*—Recently precipitated and moist hydrated oxide of bismuth was digested in a hot and strong solution of tartaric acid, in which, however, the oxide was but sparingly soluble. With the current from three cells a bright deposit of bismuth quickly formed on a brass plate, which kept this character for some time, but eventually assumed a darkish colour, due to the formation of non-reguline metal, which could be rubbed off the plate with the finger. This powdery metal was not black, as is most generally the case, but of a somewhat brown colour.

29. *Tartrates of Bismuth and Ammonia.*—With a view to improve the character of the deposit, a solution of tartrate of ammonia was gradually added to the preceding bath, when it was found that the deposits became brightened and retained their reguline character. A granular salt, however, formed upon the cathode, which eventually prevented the metal from depositing. Very little hydrogen was given off, and the anode remained tolerably clean.

30. *Salicylate of Bismuth.*—A boiling solution of salicylic acid was first prepared, to which was added moist hydrated oxide of bismuth, and the mixture was then boiled for a few minutes. It was then set aside to cool and settle, and the clear liquor afterwards decanted and electrolysed with the current from three cells. After about one minute's immersion, a slight film of bismuth formed on the brass cathode; on moving the plate it was found that grey flocculent particles fell from its corners, which floated on the surface of the solution. Large bubbles of hydrogen lodged on the plate, and it is probable that the grey matter referred to was spongy metallic bismuth liberated from the plate by the bubbles of gas.

31. *Bismuth Nitrate in Sodium Chloride.*—A concentrated solution of nitrate of bismuth was added, a little at a time, to a saturated solution of common salt, when a white precipitate of oxychloride of bismuth was formed, which immediately dissolved in the saline solution; further additions of the nitrate were given until the solution became nearly saturated. The bismuth solution thus formed being too strong for the deposition of reguline metal, even with the current from one cell only, it was diluted from time to time with the salt solution, since water alone would have precipitated the metal as oxychloride. When the solution was diluted with about four volumes of the saline solution, the metal deposited at once in the form of a black, spongy coating. But when it had become reduced in metallic strength, by the addition of about eight times its bulk, with the solution of salt, the deposition proceeded more slowly, and the metal became reguline. The film, however, soon blackened, and it was found necessary to remove nearly the whole of the anode, leaving only one corner of it in the bath, when the operation progressed more favourably for a time, but eventually

became again black. A large addition of salt solution was next given, by which time the solution became very weak in metal, but the deposits afterwards obtained, though much improved, were still disposed to become spongy at the corners of the plate, even when the cathode was kept in motion and a very small anode surface immersed.

32. *Ferrocyanide of Bismuth in Chloride of Sodium.*—A solution of chloride of bismuth was added to one of ferrocyanide of potassium, when a copious green precipitate was formed, to which was added a strong solution of common salt, which at once dissolved it, forming an olive-green solution. This was electrolysed with the current from a single Daniell, when, on immersing a clean brass plate, it at once received a coating a bismuth, which, however, was rather patchy and irregular. The plate was then constantly rubbed while in the bath for several minutes, when a perfectly uniform, bright, and reguline film of metal of good colour was obtained.

33. *Ferrocyanide of Bismuth in Chloride of Sodium.*—To form a bath of this constitution, a solution of chloride of bismuth was added to one of ferrocyanide of potassium, when a pale, greenish precipitate deposited, which was afterwards added to a saturated solution of common salt, in which it dissolved freely, forming a nearly colourless solution. This bath was electrolysed with the current from one cell, when a brass cathode quickly became coated with a bright film of bismuth, which was much more uniform than in the preceding experiment. There was a slight evolution of gas at the cathode, and the anode presented a perfectly clean surface, which, however, was crystalline. After about half an hour's immersion of the plates it was found that the lower part of the cathode was enveloped in a black mass of non-reguline metal, which extended to about half an inch in width all round the plate.

34. It was now determined to electrolyse a solution of chloride of sodium, using a bismuth anode and brass cathode as before, with a view to see how soon the latter would receive a deposit of the metal. Three cells were employed, and after about one minute's immersion of the cathode, black spongy bismuth formed at the corners of the brass plate, and in a few minutes after, a considerable quantity of metal in the same condition was found at the bottom of the vessel, while at the same time the solution became turbid from the formation of hydrated oxide by the action of the caustic soda resulting from the decomposition. On examining the cathode it was noticed that streaks of metallic bismuth appeared on portions of each side of the brass plate.

BY SIMPLE IMMERSION.

Solution of Bismuth.	On Zinc.	On Iron.	On Copper and Brass.	On Cobalt.
Acetate	Prompt deposit	Instantaneous deposit	...	Slight film.
Basic nitrate in water.	Slight film	Slight film	—	—
Sulphate with citrate	Same	Same	...	Same.
Chloride	Instantaneous black spongy deposit	Instantaneous black deposit	Metallic film.	—
Citrate and ammonia citrate	Metallic film	Metallic film	...	Same.
Chlorides bismuth and potash	Instantaneous black deposit	Instantaneous black deposit	Metallic film.	Chemical action.
Ferrocyanide in potassium cyanide	Metallic film	...	Same.	—
Iodide in cyanide potassium	Slight film	...	Slight film	Slight film.
Nitrate with nitrate of ammonia	Prompt film	Prompt film	Same	Same.
Oxalate	Metallic film	Metallic film	...	Prompt film.
Nitrate in acetic acid	Instantaneous film	Instantaneous film	...	Very slight film.
Iodide in potash	Slight film	...	Dark orange ring	Same.
Chloride in chloride of ammonia	Metallic film	Metallic film	Slight film	Metallic film.
Sulphate with ammonia sulphate	Same	Same	Same as brass	Same.
Sulphate with potash sulphate	Metallic film	Same	Metallic film	Same.

THE BRITISH ASSOCIATION.

The meeting of the British Association will open on Wednesday, September 11, at Newcastle. The Finance Committee, which met last Thursday, have decided to engage the St. George's Hall for the president's address and the three evening lectures. The estimate from Messrs. Holmes and Co. for the lighting the museum by electricity for the two soirées to be held on the 12th and 17th September was accepted.

The mayor announced that the Corporation of Newcastle intended to give the first soirée on the Thursday, and, therefore, the second soirée will be given by the local general committee. As to the reception-rooms, the secretaries reported that they had taken Prof. Flower and the deputation round the reception-rooms, and they had expressed very great satisfaction with them for their adaptability to the purpose of the meetings. An estimate was being made of the cost of erecting temporary lavatory accommodation at the Medical College, and putting up diagram screens, etc., in the section-rooms. This estimate was in the hands of Mr. Arch. Dunn and Dr. Dunn, and was not yet completed. The committee agreed to leave the matter in the hands of these gentlemen for settlement. It was reported, with reference to lodgings and hospitable arrangements, that Messrs. Watson and Sons, estate agents, New Bridge-street, had been instructed to engage lodgings for the guests at Newcastle, Tynemouth, Witley, and Cullercoats. The proof of the first lodging list showed that about 120 rooms had been obtained, exclusive of 100 rooms in Durham. It is estimated that something like 500 or 600 rooms will be required altogether. The list is still being compiled, and the secretaries will be glad to receive information from those who have lodgings to let. The offer from Messrs. Barkas and Sons to give an invitation concert to the members on Saturday evening, September 14, was accepted, and the secretaries were instructed to write a letter of thanks to the lessees of the Art Gallery for their kindness. An offer had been received from the committee of the Church Girls' School, Jesmond-road, to put their hall use at the service of the committee for the use of the sectional secretaries free of rent, and it was gratefully accepted, the secretaries being instructed to make arrangements for the necessary furnishing, etc. A tender from Messrs. Thomas Gray and Co. to fix posters at the various railway stations and to placard the town and district was accepted. A circular has been prepared for circulation in the town and district, of which the following is a copy:

PRELIMINARY PROGRAMME.

(These arrangements are subject to possible minor alterations.)
General and evening meetings, open to members of the association only.

Wednesday, Sept. 11.—Horticultural show. President's address, 8 p.m.

Thursday, Sept. 12.—Reading of papers in the various sections, 11 a.m. Soirée, given by the Mayor and Corporation of Newcastle, 8.30 p.m.

Friday, Sept. 13.—Reading of papers, 11 a.m. Lecture on the "Hardening and Tempering of Steel," by Prof. Roberts-Austen, F.R.S., F.C.S., 8 p.m.

Saturday, Sept. 14.—Reading of papers, 11 a.m. Half-day excursions. Conferring of degrees at Durham University, 2 p.m.; and invitation luncheon to 200 members of the British Association, 3 p.m. Service in Cathedral, 4 p.m. Lecture to the working classes on the "Forth Bridge," by Benjamin Baker, Esq., C.E., 8 p.m.

The lectures delivered on Saturday evenings during the week of the meeting are intended solely for the working classes; they are not included in the proceedings of the association, and members, other than officials, are not eligible for admission.

Sunday, Sept. 15.—Special services at the various churches in the city.

Monday, Sept. 16.—Reading of papers, 11 a.m. Lecture on "How Plants Maintain Themselves in the Struggle for Existence," by Walter Gardiner, Esq., M.A., F.L.S., 8 p.m.

Tuesday, Sept. 17.—Reading of papers, 11 a.m. Soirée, given by the Local Executive Committee, 8.30 p.m.

Wednesday, Sept. 18.—Concluding general meeting, 2.30 p.m.

Thursday, Sept. 19.—Whole day excursions.
No special invitation will be required to either of the soirées, but members will be admitted on presentation of their tickets.

THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence ; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices :

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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IMPORTANT NOTICE.

We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No paper that we know ever refuses Subscribers or Advertisers. Nor do we; in fact, we invite them, believing that they will get full value for their money.

Specimen copies of the paper will be sent on request.

BALLOONING.

We all know the tale of the old woman who, firm in her faith in the efficacy of a war cry, was content to attribute all good and evil to "blessed Melchisedec." Just so, certain would-be expounders of science, can explain everything by an appeal to electricity. What electricity cannot do is impossible to say, but we do know that many things can be done by its aid, most of which involve merely a question of money. Still, that is no reason for dragging in electricity to fill the place of every "unknown quantity." The Balloon Society has, for once in a way, talked about balloons and ballooning, adopting a resolution to the effect "that the collapse of the balloon Eclipse was due to the sudden mixture of air, electrically charged, with the gas in the balloon, causing the latter to explode." We congratulate Mr. W. H. Le Fevre, C.E., with getting so bold advertisement as this paragraph which our sapient dailies insert with great gusto. This wise president says "a scientific problem has been determined—viz.: that an admixture of air, electrically charged, with gas would cause an explosion without ignition." The excessive timidity under which we exist in the constant endeavour to hide our ignorance of things electrical compels us to accept the dictum of Mr. Le Fevre. Still, a few bewildering doubts do exist as to the correctness of the "dictum," and, upon second thoughts, it may be as well not to pledge ourselves to accept it. Spontaneous combustion, air electrically charged, combustion without ignition, are pretty theories, fit for consideration by the Balloon Society, but not for men who desire to walk in paths of rectitude in matters electrical. Dr. Lodge has just favoured the world with the best book on Modern Views of Electricity, but we doubt if a single line in Dr. Lodge's book supports the theory of the Balloon Society. True, the tendency of the moderns is towards the idea that the dielectric plays a more important part in electrical phenomena than was held to be true a short time ago, but we venture to think that air electrically charged is a new departure even to the most modern students. Then in addition we are to get explosion without ignition. What do these men know about explosions? Do they refer to the ordinarily accepted term, which involves the combination of different chemical constituents, and the generation of other chemical combinations usually occupying a much larger volume of space? We know the result of ordinary coal gas in combustion with the oxygen of the air; we know the result of hydrogen similarly combining, and it is difficult to imagine a different result if the air be "electrically charged." If the Balloon Society are referring to thunderstorm phenomena, and the vulgar (common) statement that the "air is full of electricity," we can understand what is meant, though the expression is

incorrect as applied to a "charge." So far as we know, it is impossible to have a "charge" with a dielectric only. Supposing the balloon to be similar to a Leyden jar, the material forming the balloon to be the non-conductor, with internal and external conductors, say, due to external and internal moisture deposited on the non-conductor, then we might have a charge. It is not impossible to conceive, under such supposition, that the varying electrical conditions due to different heights or suspended moisture might be indicated with suitable apparatus, but allowing all this, where does combustion without ignition come in? It may be stupidity, but to the ordinary electrical mind it appears that the reduction of the Leyden jar coatings to a normal potential is usually accompanied by sparking, and we have known the electric spark to ignite gases. In fact, most people, when venturing to lecture on chemical and electrical matters, perform an experiment of this kind. Perhaps it will be as well to specifically mention the points on which we differ with the Balloon Society. (1) No admixture of air with either coal gas or with hydrogen will lead to spontaneous combustion; (2) No such admixture will cause explosion without ignition; (3) You cannot "electrically charge" a gallon or any volume of air.

Now it may be said that we know very well what the Balloon Society means, and that our objections are hypocritical. It was a popular society talking in popular language on a subject the society is specially constituted to consider. The popular notions about electricity are sufficiently loose and incorrect now, without a quasi-scientific society advertising itself by the promulgation of views directly opposite to those held by men who have specially studied these matters.

WOODHOUSE AND RAWSON.

The formation of "Woodhouse and Rawson United" is the reorganisation of companies under one roof that were originally under one roof and by a previous scheme had been separately constituted. We always looked upon the previous action as a mistake. A manufacturing or a business concern may well be organised into different departments, but the departments should be controlled from one centre, so that all work harmoniously and amicably together. If the business is one concern it can be more economically carried out than if each department is a separate company having one object, viz., to pay its shareholders. It will be seen, therefore, that we should support this return to the original basis.

Company promoting is a thing *sui generis*. Those who study it take the greatest precautions to be successful, and from their point of view they are

justified. Still, we once more complain that these manufacturing concerns are generally brought out so that the technical press can offer no advice one way or the other to intending investors. We hold that the tendency is to make these concerns momentary financial speculations, rather than permanent investments. The lists are opened after the technical press is issued in one week and closed before it is issued in another, so that whatever might be said can have no effect upon the lists. This is the usual grumble, and must be accepted as the reason for not entering into details as to the past, present, and future of this company, as these would now possess no influence and but little interest.

We may, however, say that, according to our advices, a large part of the success achieved has been through the successful formation of companies to take up new patents, worked out under the company's supervision. It would have been better if the prospectus had shown the proportion of profits arising from pure manufacture and the exploitation of new patents; but, as a matter of fact, shareholders do not trouble about how the profits are obtained so long as the profits are substantial and continuous. A manufacturer has far better opportunities for knowing what is required in the industry, and whether a patent contains the germ of apparatus which can be made commercially successful, and it is to his interest to be connected with patents of this kind. In other words, the patentee and the manufacturer, working together, are far more likely to obtain mutual advantages than when working in antagonism. Every manufacturer is more or less an exploiter of new patents. Some he takes himself, others he brings to perfection, and then hands over to a new company as being either too big or otherwise unsuitable for him. The one thing to be avoided is the making of exploitation the first and not the subsidiary purpose of the concern. We trust the new organization will have a long and a prosperous career.

LITERATURE.

Modern Views of Electricity. By Oliver J. Lodge, D.Sc., LL.D., F.R.S., Prof. of Experimental Physics in University College, Liverpool. With illustrations. Macmillan and Co., 1889.

PRELIMINARY.

So far as electricity is concerned this is *the* book of the year. It is, perhaps, from the theorist's point of view, the most important that has been issued since Prof. Clerk Maxwell's work, and certainly so from the popular, or rather the non-mathematical standpoint. Before entering into any consideration of Prof. Lodge's views, before giving any indication of the contents of his work, we must define our own position as appealing on the whole more directly to the practical rather than to the theoretical reader. Still, there are questions of theoretical importance, or of so great interest that all the space we could devote to their consideration would be all too inadequate for the purpose. In our opinion

theory invariably follows practice. The practical man leads the way. The theorist follows, and, by putting the results obtained by the former into something like order, saves learners the loss of much time and trouble. There are the facts, gathered and analysed. The lessons to be learned are selected and grouped, so that he who comes after, starts more or less easily at the point where his predecessor left off. From the earliest times of scientific investigation up to the present, the procedure of theorists has been the same. They make theories to fit the facts as they know them. Further investigation leads to further facts, and these necessitate new theories. It would lead to endless discussion to put down the proofs of this statement, if the statement is not admitted as correct. Newton and Kepler put forward theories which stand unassailable as yet, but in almost every other direction the individual student has lived long enough to see theory after theory give place to others more in accord with the facts obtained by recent investigations. The tendency of the modern is towards the ether. By its aid everything is to be explained, or is explained, but to the conservative mind the end is as far off as it was in the time of the ancient Chaldeans and Egyptians. The "ether" may be an intangible fancy, easily put aside by future generations, and our accepted ideas about it may seem to them as ludicrous as were some of the notions of Herodotus upon ethnological questions. Scientific theories are things of change, and it is the kaleidoscopic beauty that attracts the human mind. One of our functions—one of the functions of the mind—is to see difficulties, and this ever-fleeting change is but a fulfilment of the laws that regulate our destiny. Time was, is, and will be. Little more is known, but this is certain—that perfection in the human is unobtainable, and being unobtainable and, we believe, unapproachable, the number of theories that may be advanced before the real laws regulating Nature's actions are known is infinite. Scientific men have taught and written as strongly before, but generations later on have looked upon their conclusions as those obtained with a superficial knowledge of the subject only. Our opinion then is, that however masterly, however beautiful, however recondite the theories of Maxwell, Thomson, Lodge, and others, they are but the breath of to-day, and to-morrow must give place to others, which in their turn will prove as attractive and for the moment as convincing. Can we now suggest a better theory than that held by the scientific giants? No. To us it is to be accepted as the outcome of the most careful investigations of the ablest thinkers, and before it is rejected new facts must be obtained which upon application the theory does not explain. Of Dr. Lodge's deep conviction, nothing will prove better than the following extract from the preface:

"Some of the details of my explanations may be wrong (though I hope not), and all must be capable of ultimate improvement; but as to the main doctrine concerning the nature of electricity, though I call it a 'view,' it is to me no view, but a conviction. Few things in physical science appear to me more certain than that what has so long been called electricity is a form, or rather mode, of manifestation of the ether. Such words as 'electrification,' 'electric,' may remain; 'electricity' may gradually have to go." It can be noticed that whereas in the earlier part of the book the word "electricity" occurs frequently and the word "ether" seldom, in the latter portion this order of frequency is inverted.

A rough and crude statement, adapted for popular use, is that electricity and ether are identical; but that is not all that has to be said, for there are two opposite kinds of electricity, and there are not two ethers. But there may be two aspects of one ether, just as there are two sides to a sheet of paper, or two aspects to a transparent clock-face; and similarly may positive and negative electricity be two aspects, or, as I have sometimes called them by chemical analogy, "components" of the ether. Anything that can be sheared—and ether is sheared by every E.M.F. applied to it—must consist of two parts sufficiently different to travel or to be displaced in opposite directions.

The object of this book is to present to the non-mathe-

matical reader the modern view of the etherial theory of electricity. That will, perhaps, have been gathered from what has previously been said. Dr. Lodge expresses a belief that the answer to "What is ether?" will not be long a-coming, and will probably come before the answer to "What is matter?" and in this connection refers to Prof. Fitzgerald's contributions to *Nature*, to Mr. Hick's paper at the British Association, v. Preface, pp. 11-12.

This preliminary notice of Prof. Lodge's book must not conclude without the expression of a decided conviction that every practical man as well as every student should carefully examine it. To our mind, there is no living exponent of these theoretical views so able as the author of this book. He writes from conviction, with a thorough knowledge of his subject, and goes straight to the point without superfluity of language. He writes for the non-mathematicians while fully conversant with the mathematics of the subject; hence his interpretation may always be relied upon as accurate.

For simplicity of treatment the subject is classified under four branches: (1) Electricity at rest, or static electricity, principally connected with the dielectric; (2) electricity in motion, wherein are considered the phenomena of conductors; (3) electricity in rotation, or magnetism; and (4) electricity in vibration, or radiation, wherein are a multitude of phenomena studied for a long time under the heading "Light."

THE (AMERICAN) BRUSH ALTERNATOR.

According to our American contemporaries, which fully illustrate and describe this machine, it is novel, compact, simple, symmetrical, and strong. A brief examination shows that it is of the alternating type; that its field-magnets are many and carried by the shaft; that the armature is fixed and absolutely free from any magnetic material; that its parts are easily accessible, and that an armature-coil may be cut out, removed, or replaced without stopping the machine.

The shaft bearings, bearing standards, base plate and armature slides are cast in one solid piece. The centre line of the shaft is 16 $\frac{1}{8}$ in. above the surface of the base plate, high enough for access to all parts of the dynamo, and low enough for steadiness and freedom from strain on foundations. The 4 in. steel shaft (tapering to 3 $\frac{1}{2}$ in. in the bearings) carries two heavy cast-iron yokepieces, 27 in. in diameter. To each of these are screwed, at equal radial and circumferential distances, the wrought-iron cores of 12 magnets of alternating polarity. The two yokepieces, with their bolts, washers, etc., weigh about 950 lb.; the magnet-cores, 308 lb.; the magnet-wire, 400 lb. Thus the whole rotating mass of cast iron, wrought iron, and copper, acts as a flywheel weighing more than 1,700 lb., and tends to neutralise any variation in the speed of the prime generator. As the nominal speed of the machine is fewer than 1,100 revolutions per minute, the structural strength is more than sufficient to meet all demands made by centrifugal force. Further than this, the mechanical stress is less when the magnets are excited than when the alternator is running without load, as the lines of magnetic force between the faces of opposing poles tend to counteract centrifugal force. In machines of larger size, as usual, the speed is less, that of the 150,000-watt dynamo being not more than 700 revolutions per minute. These larger alternators are driven by two belts, and carry a pulley at each end of the shaft.

The pulley has a 14 in. face. As it overhangs, the belt may be run to counter-shafting overhead or below. The shaft-bearing at the pulley end has 14 in. wearing surface, and the bearing at the other end 12 in.

The most interesting part of the alternator is the fixed armature, as shown (Fig. 1.) The vertical disc is occupied by flat armature-coils, made of insulated copper ribbon wound on porcelain cores. The copper ribbon of each coil is reinforced on either side with strong insulating material of the same thickness as the porcelain. One of these reinforcements is grooved and the other tongued. The coil, consisting thus of core, ribbon, and reinforcements, has an

angular width of 60deg. The upper part of each face of each coil is covered with an insulating plate $\frac{5}{16}$ of an inch thick. The coil thus built up and insulated is set in german silver holders, cut from true turned rings and held together by sunk-headed screws. Each terminal of the copper ribbon connects with a binding screw.

The six armature-coils thus mounted are carried in a german silver frame consisting of two semicircles bolted together on the line of the vertical diameter. The cross-section of this ring frame is girder-like. Into the slots of the frame slip the six mounted armature coils, the tongue on the edge of the one engaging with the groove on the edge of the next. The coils thus thrust into the intense magnetic field constitute a disc $\frac{9}{16}$ of an inch in thickness, and with an opening in the centre through which passes the revolving shaft.

The several coils are insulated carefully, and the stationary armature, as a whole, is insulated from the bed-plate on which it rests. The coils are joined in series, the binding posts adjacent to any radial line of division between the two coils constituting fixed terminals for the main line. There is no commutator; there are no collecting brushes to take the alternating current from rotating parts.

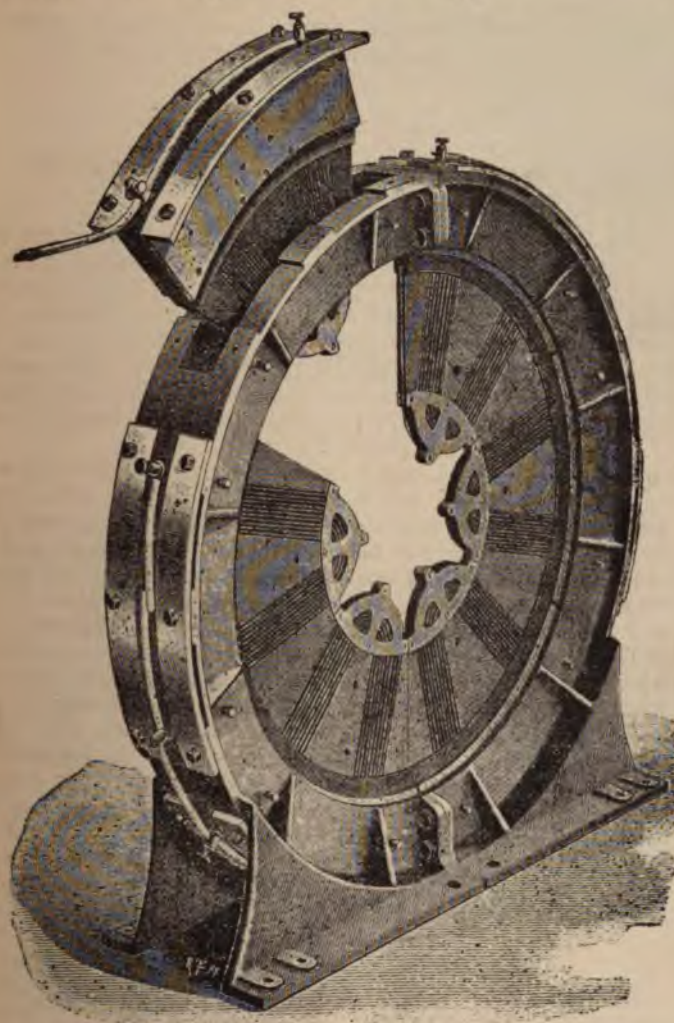


FIG. 1.

The low resistance of the armature-coils is evident. It would seem impossible for one of them to burn out. None ever has burned out. But if one should, it may be removed and a new one readily put in its place in three minutes, or the injured coil may be shunted out of the circuit and the dynamo kept running with the other five until the time for shutting down. The coil section complete weighs only about 20lb.

The whole armature may be removed by loosening the coupling bolts and sliding each half of the frame with its three coils from between the field-magnets. As each half with its coils weighs only about 100lb., no time need be wasted on cranes or blocks, and in a few minutes the armature may be back in position.

In action, the 24 field-magnets of the alternator are

excited by a direct-current Brush dynamo of the well-known form. This exciting current is carried to brushes that rest upon two uncut insulating rings, and thence through the hollow shaft to the magnets. A rheostat, worked by hand or automatically, is placed in the shunt circuit around the field-magnets of the exciter, so that perfect regulation is secured without readjustment of the brushes or any necessity of handling the high-tension alternating current.

The Brush-Pfannkuche "coreless" alternator is built at present for E.M.F. of 2,000 volts, although it would be easy to develop a difference of potential much greater.

We here find a potential curve that varies little from a horizontal line. The fall of potential in the machine from no load is less than 10 per cent., as is shown in Fig. 2, which represents a diagram taken from one of the first

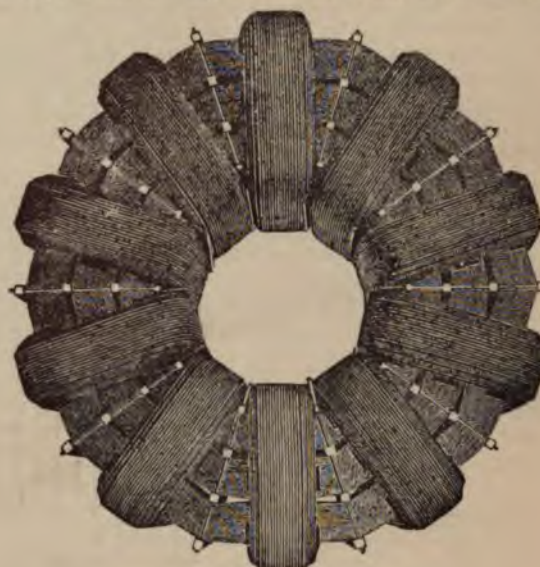


FIG. 3.

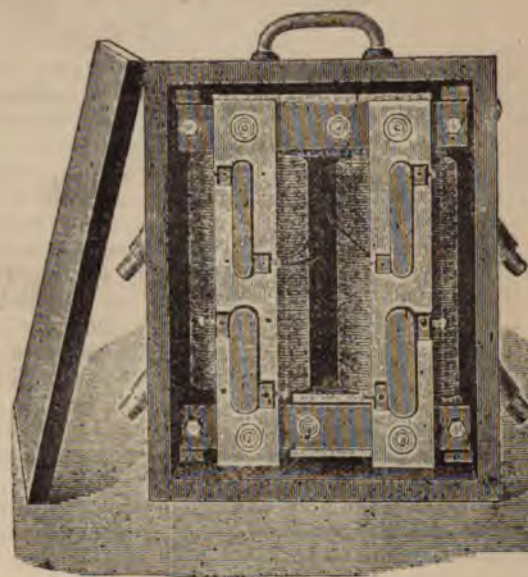


FIG. 4.

machines. All this without compound winding of any kind, a result, it is claimed, that has not been approached by any alternator with an iron core in its armature. All of the regulation needed is applied at the exciter as already described.

The principle underlying the action of the converter is the well-known principle of electrical induction. Imagine two coils of insulated wire, A and C, constituting closed circuits. Thrust C into the thoroughly insulated core of A. When a current of electricity begins to flow through C, a momentary current will flow through the wire of A, and may be detected by the movement of the needle of the galvanometer, B. The current of A is not the current of C, but it is produced (or induced) by it, and exists at its expense. This induced current in A is merely momentary; if

the current continues to flow through C, there is no further electrical disturbance in A; the needle of the galvanometer rests at the zero point. If, however, the current of C is stopped, another current will be induced in A, the two currents thus induced being opposite in direction. Thus a succession of stops and starts of the current of C (the primary) induces a corresponding series of momentary currents in A (the secondary). The relation of the direct and induced currents will be determined by the constitution of the coils, i.e., the size of the wire and the number of convolutions in the coils. Either coil may be exterior to the other, or the two may lie side by side. Of course, we are seeking merely to describe, not to obtain this inductive action.

There can be no reversal without a stop and start. Consequently, the rapidly alternating current of the dynamo just described is of the character most efficient for the development of induced currents in the secondary coil. The two coils now described constitute a converter. It only remains properly to adjust its parts for the end in view and to work its effectiveness up to the maximum.

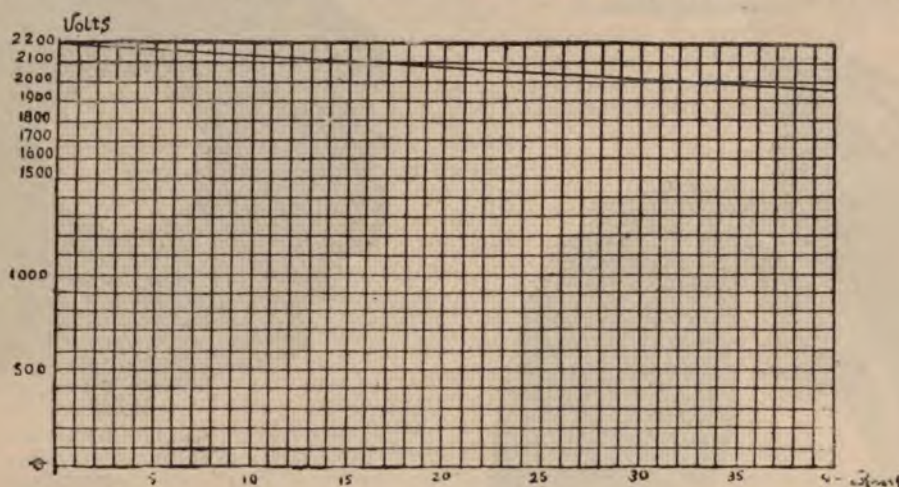


FIG. 2.

If, as is now well understood, the two coils be made alike, the size and length of the wire and the number of convolutions being the same, the induced current will resemble the inducing current as to pressure (potential, E.M.F., volts) and current strength (amperes). If the secondary coil be made of a greater number of turns of finer wire, the current strength will be reduced and the tension correspondingly increased. This is the effect produced in the ordinary induction or Ruhmkorff coil. If, on the other hand, the secondary coil be made of fewer turns of larger wire, the pressure will be reduced and the current strength increased. This is the end we now desire, and the converter is thus constituted. As in the Ruhmkorff coil and the armature of the ordinary dynamo, the inductive effect is heightened by an ordinary core. In the Brush Company's converter here represented (Fig. 3) the core consists of a polygonal ring, made of insulated iron wire of the best quality, so wound as to leave several concentric air spaces in the core. In the converters of the smaller sizes, the core is built up of perforated thin iron plates (Fig. 4). In either case the iron is so divided that the efficiency of the converter is little less with half than with full load.

Upon each side of this core or iron ring is wound a single layer of heavy copper wire. The four or five single-layer coils carried by each half of the core are joined in series, and the two groups, borne by the two halves of the core, are joined in multiple, the whole constituting the secondary coil. The terminals of this secondary coil connect with the secondary main line running into houses and supplying current for the lamps. Most of the converters are wound so as to give a secondary current of about 100 volts, but may instantly be connected to give 50 volts, and twice as many amperes as before. They are made in sizes that supply each from five to 250 16 c.p. lamps or more.

Between the fine iron wire of the core and the heavy copper wire of the superposed secondary coil insulating pads, one-eighth of an inch thick, are placed at the corners

of the core. Between these insulating corner pieces are insulating air spaces. Thus, the copper and the iron are separated from each other at the corners of the core by their respective coverings and the insulating pads, and at all other points by their respective coverings and open air spaces, the latter affording ample ventilation and facility of examination.

Over each of these single-layer parts of the secondary coil are bound a few layers of smaller copper wire to form a corresponding part of the primary coil. These corresponding parts of the secondary and primary coils are separated from each other by insulating pads at the corners and intervening air spaces in the same manner and with the same advantages as previously described.

Nothing could be more satisfactory than the ventilation of these converters. The insulation resistance is exceedingly high. It is impossible so to overload the wire of the primary circuit as to force its current into the secondary circuit. In other words, the high-tension current cannot pass the converter. The converters are tested at the factory with double load, and no one has ever given out. Yet, to

make safety doubly sure, overloading is made impossible by the use of safety fuses for the primary coils. These are extra long, so mounted on slate or porcelain strips that they may be removed or replaced with the fingers merely, and without touching any metallic part of the converter.

The converter-coils, with safety fuses, etc., are placed in wind and weather proof cast-iron boxes, and may be placed wherever most convenient, the governing principle being to do as much work as possible with the less expensive primary wire, and to shorten the more costly secondary main. Thus, the converter, as the local centre of distribution, is brought near the lamps it is to feed, and placed on the nearest line pole or on the wall of the building.

NEW COMPANIES FOR THE FIRST HALF-YEAR OF 1889.

The *Investors' Guardian* newspaper of the 20th inst. publishes the following particulars relative to new limited companies registered during the past six months.

Description of Companies.	First Six Months of 1889.	First Six Months of 1888.	First Six Months of 1887.
Miscellaneous.....	13,034,890	37,931,284	27,064,251
Manufacturing	17,388,905	6,577,803	2,880,000
Mining	18,244,378	38,388,000	15,850,990
Trading	5,958,784	10,639,570	485,700
Trams	544,050	310,000	1,100,000
Shipping.....	2,171,710	4,076,200	2,252,275
Breweries	9,131,000	14,823,000	4,837,000
Railways.....	8,993,830	26,520,000	7,160,000
Land and Agriculture	6,755,200	7,299,630	8,402,000
Electric	3,563,600	2,254,000	1,047,000
Financial and Banks.....	27,054,500	94,682,750	8,810,240
Gas and Water	1,975,500	2,241,600	844,600
Telephone	250,000	20,000,000	70,000
Insurance	231,000	3,412,000	2,306,000
Hotels	395,150	946,000	555,000
	115,692,497	270,101,837	83,665,056

STANDARD TYPES OF APPARATUS.

The London Chamber of Commerce has issued a circular to the following effect: "The sub committee appointed by the general committee of the Electrical Section of this Chamber, to consider the recommendation of standard or uniform types, desire to obtain information as to the extent to which the British Association screw thread has been adopted by the electrical trade up to the present. No steps have been taken by the British Association to bring their standard screw gauge before the trade other than the publication in their 1884 (Montreal) report of the report of their committee. This committee consisted of Sir Joseph Whitworth, Sir W. Thomson, Sir F. J. Bramwell, Mr. A. Stroh, Mr. Beck, Mr. W. H. Preece, Mr. R. E. Crompton, Mr. E. Rigg, Mr. Alec. Neve Foster, Mr. L. Clark, Mr. E. T. Wood, and Mr. Buckney, and were 'appointed for the purpose of determining a gauge for the manufacture of the various small screws used in telegraphic and electrical apparatus, in blockwork, and for other analogous purposes.' In the report of the British Association for 1885 (Aberdeen) it is stated that the standard screws 'have been officially adopted by the telegraph department of the Post Office, and this step alone may be relied upon to ensure their general adoption by the telegraphic and electric instrument trades in the course of a few years.'

"In the 1887 (Manchester) report the following statement was made by Mr. Preece: 'Owing to the large number of telegraph instruments made by different manufacturers, the number of screws of different forms and sizes in use was very great, and this was found to be a great disadvantage and a great source of expense. When the Post Office commenced to manufacture its own apparatus it was decided to make all parts to template, so as to be interchangeable, and it was also decided to adopt some standard for screws. The standard recommended by the committee appointed by the British Association is now being introduced in all instruments and apparatus manufactured by and for the Post Office Department, a circular to that effect having been issued to all firms manufacturing for the G. P. O.' Notwithstanding the above, a considerable number of manufacturers of electrical instruments are still quite unacquainted with these screws, and the committee, feeling that the practical value of such a standard depends largely, if not entirely, on the extent to which it is adopted, invite communications from the trade upon the subject, and for that purpose have drawn up a set of questions, sent herewith, to which your answers are requested. It should be noted that the enclosed questions need not entail any disclosures whatever as to the actual extent of your business; only the proportion or percentage is asked for, but actual figures may be given. The result of the analysis of the answers to these questions will be communicated to the members of the London Chamber of Commerce, in order that those who do not use the screws may see whether their use is sufficiently general to induce them to adopt them.

"QUESTIONS.

"1. Do you use the British Association standard screw gauge in your manufacturing business?

"2. If so, what is the proportion of small screws of this gauge compared with other screws smaller than the Whitworth sizes used by you?

"3. Also, if so, do you find that for ordinary purposes you require to use other screws than those of the Whitworth and the British Association gauges?

"4. If you do not use the British Association screw, have you any reason other than that you do not care to incur the expense and trouble involved by their adoption?"

Telephone Tickets.—The Southern New England Telephone Company are introducing a plan by which non-subscribers can use the telephones of their neighbours at a small charge. Tickets costing ten cents each in strips of five will be given, and when the holder of a ticket uses the instrument he will leave a ticket with the subscriber whose instrument he uses. This ticket will be redeemed by the company at five cents, thus forming a small fee each to the company and to the subscriber.

THE ELECTRICAL EXHIBITION IN BINGLEY HALL.

Everything is well in train for the Electrical Exhibition which is to be held in Bingley Hall during the months of August, September, and October, and if the present rate of progress in completing the arrangements is maintained there can be no doubt that by noon on Thursday next, when Lady Randolph Churchill will formally open the exhibition, all the sections will be in perfect order, and the huge machine ready to run smoothly to the end of the period indicated. With the exception of the very interesting collection of industrial appliances, representing Midland manufactures, which was got together in Bingley Hall in connection with the visit of the British Association to Birmingham in 1886, our city has been altogether out of the running in the matter of exhibitions such as have been held at Liverpool, Manchester, Glasgow, Newcastle-on-Tyne, and other centres. About the middle of last year, when the phenomenal success of the Manchester Exhibition was fresh in mind, and the Glasgow show was being attended by hundreds of thousands of people from all parts of the kingdom, the idea was broached of a similar exhibition for Birmingham in 1889 or 1890. The then Mayor (Alderman Pollack) was approached, together with other prominent public men, but the project found little favour in their eyes, and was ultimately abandoned. Later in the year, when Messrs. Fowler and Lancaster, electrical engineers, were engaged in carrying out a large contract in connection with the block of buildings in Corporation-street and Martineau-street, another suggestion was made, that an exhibition of electrical appliances should be promoted, and these gentlemen warmly espoused and encouraged the project which in a few days will be brought to such a successful issue. A nucleus of action being thus formed, the scheme proceeded rapidly, and on the formation of a provisional committee, Mr. J. P. Sharp was appointed architect to make the necessary structural arrangements in Bingley Hall, which had been secured for the purpose, and the efficient assistance of Mr. T. C. Sharp was enlisted as secretary and manager. Messrs. Fowler and Lancaster were appointed engineers to the exhibition. A considerable number of influential noblemen and gentlemen in the Midland Counties consented to become patrons of the intended exhibition, and many of them also committed themselves to a financial guarantee; and the project being thus secured against loss, invitations were issued to all manufacturers of electrical appliances and kindred products to send in exhibits. The result was that the whole of the available space was quickly applied for and allotted, and among the promised exhibits were many novel applications of electricity to industrial purposes, which will be shown in operation.

The general exhibits will be arranged in the main hall and galleries, and the gymnasium and other annexes will be devoted to purposes which are described below.

The gymnasium is being laid out as a garden, the *parterres* of which will be intersected by walks, on which lounges and arbours for the convenience and comfort of visitors will be placed. Messrs. Vertegans are "planting" the gardens, the design for which is singularly pretty. With the aid of the scene painter, a fine background of mountain country will be obtained, with water falling over the rocks. The water will be real, and after coursing over a bed of rockery work the stream will be carried under a rustic bridge, and meander peacefully among the beds of flowers and shrubberies. The evening concerts, which are to form one of the most attractive features of the exhibition, will be given in these gardens, and when the scene is illuminated by powerful electric lamps the delusion will be as complete as it can well be made. Smoking will be permitted in the gardens, and refreshments will be served in the arbours and other resting-places. Around the galleries of the gymnasium there will run an aerial railway on what is known among electricians as the telfer principle, which has been for the first time applied to recreation of this kind. A locomotive and six cars, the cars somewhat resembling a double sedan chair in form, and each carrying two passengers, will run along a strong wire, the motive-power being communicated by a current through the wire. The circuit of the galleries will occupy about a minute. As the engine and cars will run at a level of less than 2ft. from the floor of the galleries, there will be no risk of injury to the passengers, and as the motion of the aerial railway will closely resemble that of the switchback, the ride will no doubt be largely patronised by the visitors. The motive-power will be supplied from a large dynamo in the machinery hall.

In another part of the hall a coalmine has been constructed on the longwall system, as adopted in the Staffordshire mining districts, and visitors to the mine will be able to witness the methods of working coal under various conditions, and the state of affairs which leads to falls and the generation and evolution of gas. By mechanical devices the descent will appear much greater than it really is, and the cars, tubs, and waggons which will be employed have been kindly lent by the Earl of Shrewsbury from his Breerton collieries.

Messrs. Burroughes and Watts have secured a portion of the annexe running out of the gallery nearest Cambridge-street, and placed in it a large billiard table, on which exhibition games will be played by champion billiard players. In the same annexe a representation of a jungle has been created, operated by electrical apparatus. Birds, rabbits, and other animals will pop out of the trees and underwood to be shot at, and retire to be shot at again when the machinery brings them once more in view.

The lighting of the hall has been divided into sections, and entrusted to the leading electric lighting firms, among them the Anglo-American Brush Company, Elwell-Parker, Limited (Wolverhampton), Ernest Scott and Co. (Newcastle-on-Tyne), The Planet Electric Light Company (London), Messrs. Goldston (Middlesbrough), Shippey Brothers (London), and Messrs. Thomson and Houston (London). All the various methods of lighting by electricity will thus be illustrated. The motors for driving machinery for the working exhibits will be supplied by Elwell-Parker's, Messrs. Immisch and Co., Crompton and Co., and Messrs. Launce, Paris, and Scott; the engines by Messrs. Rushton and Proctor (Lincoln), Messrs. Robey and Co. (Lincoln), and Messrs. Greenwood and Batley (Leeds); and the boilers by Messrs. Galloway and Sons, of Manchester.

Messrs. Crompton and Co. will exhibit an electric crane at work, and Messrs. Laing, Wharton, and Down will show their process of welding tubes by electricity, which should prove very interesting to visitors from the Midland hardware districts. The Lords of the Admiralty have contributed a special exhibit of Whitehead torpedoes, submarine mines, diving boards, and all the electric appliances connected with torpedo warfare; and the Corporation of Birmingham have lent from the Art Gallery and Museum a dynamo, which is believed to have been the first applied to the process of electro-plating. Messrs. Turner and Co. will exhibit the processes of making steel pens, and bread-making, sweetmaking, and many other industries will be exhibited in operation. The Edison-Swan Company will have a very attractive show of incandescent lamps, ranging in size from the minute instrument used by surgeons for examinations of the throat and mouth to lamps of 1,000-candle capacity. The whole of these lamps will be lit at night, and will make a brilliant display. Messrs. Buller, Johnson, and Co., of Dudley, have erected a representation of the roofs of houses on which to place a picturesque arrangement of telegraph poles on which to exhibit the insulators which are their special manufacture.

As is indicated above, the exhibition will be opened at one o'clock on Thursday next by Lady Randolph Churchill, who will be accompanied by Lord Randolph Churchill, Viscount and Lady Curzon, and Sir James and Lady Sawyer. About 350 invitations have been issued to an informal luncheon in the gardens, to meet Lady Randolph Churchill before the opening ceremony, and among the ladies and gentlemen expected to be present are Lord and Lady Aylesford, Sir Thomas Bazley, and of Sir Walter and Lady Foster. The opening ceremony will be of brief duration, and subsequently the invited guests will make the first public tour of the exhibition.

The promoters have made the exhibition widely known, and they rely on a large influx of visitors from districts outside Birmingham and its immediate surroundings. Arrangements have been made with all the railway companies running into Birmingham to run frequent excursions at fares which will include admission to the exhibition.—*Birmingham Daily Gazette.*

ELECTRIC STREET RAILWAYS.

A COMPARISON BETWEEN THE STORAGE BATTERY AND DIRECT SYSTEMS.

(Concluded from page 57.)

The fear of obstruction of a conduit by dirt or snow is groundless. The slot opening of the conduit is but $\frac{1}{2}$ of an inch wide, and the body of the conduit is in all cases connected with sewers, and provided with proper catch-pits at intervals. The amount of material which can in any case enter a conduit is very small and readily disposed of. This is a matter of actual practical experience, both with electric and cable conduits, and this experience has proved that the cleaning of a conduit adds practically nothing to the cleaning of the road-bed, which must be done in any case.

It has been apprehended that where the conduit system is used a whole road might be blocked by reason of a break at some point in the line. It must be remembered that an electric system is far less dependent upon its conductors than a cable railway is upon its rope. There is no wear and tear upon the conductors. They are fixed firmly in position in a small conduit, less liable to breakage than the rails themselves, and much less liable to interruption than the overhead wires of electric light companies, which have but little trouble from this cause. It may also be said that should both conduit and conductors be wholly broken through at any

point, it is the work of but a few moments to make an electrical connection around the break, which will permit the passage of current to the rest of the line; while, as in electric lighting systems, feeding-wires may also be introduced at different points along the line, so that a break in the main line could not interrupt the operation of the line beyond the break.

Danger from the conduit system is wholly out of the question. Neither man nor animal can by any accident come in contact with the current, which is, moreover, of such low potential as to be perfectly harmless.

It may be further said that each car of a conduit system is no more dependent upon the conduit than a storage battery car is upon the rails. The contact device leading into the conduit through the slot is readily withdrawn at any point along the line, leaving nothing behind. The desirability of having a car able to travel over other tracks than those on which it normally runs is not a matter of practical importance; in 99 cases out of 100 a street car has a definite route.

Where roads are already laid, conduits can be added to them without change in the rails, as the motor attached to the car adds but little weight to the load to be borne, while in a storage battery car the immense weight must inevitably necessitate the complete reconstruction of the road-bed.

The question of tractive weight is another imaginary difficulty often brought up against the direct system, and which the great weight of the storage battery is claimed to overcome. Ignorance of the principles involved, and the fact that many people, when discussing "traction," have in mind a locomotive adapted to draw a long train, occasion this error. The best answer to the objection is that a large number of electric cars are in successful operation daily in this country, using the direct system on roads where the worst of grades and curves are encountered.

We now come more definitely to the comparative cost of the storage battery and the direct systems. It is to be borne in mind in the following figures that the direct system is already a practical success, and reliable statements and figures can be given in regard to it. With the storage battery, on the other hand, it is necessary to take the statements which its enthusiastic promoters make. It has never been in practical use except for speculative purposes, and exact details have been carefully guarded. The figures in regard to it have, moreover, been grossly tampered with.

It will be readily seen that in a storage battery car, requiring several tons of batteries for its propulsion, there must be an additional weight in the motor and a stronger construction of car. In fact, for this reason, as well as from difficulty in regulation, two motors are used upon every car. Such a car, gotten up for exhibition purposes, and now making occasional trips in New York city, is acknowledged to have a weight of six and one-half tons, or 13,000lb. A corresponding car, equipped for the direct system, weighs 6,600lb., or about half as much. This means that the additional weight alone in a storage battery car necessitates at the central station twice the dynamo and engine plant, and that twice as much power must be paid for daily for each car. Nor is this result materially altered when the average load which may be expected is added. In Boston (1886) the average load per car mile was ten passengers, or about 1,400lb. Adding this weight to each of the two figures given above, we have 8,000lb. for the direct-system car, and 14,400lb. for the storage battery car.

To this difference in cost for central-station plant, and in running expenses occasioned by the difference in weight to be moved, must be added, moreover, the loss in the conversion of the energy through the battery. In the direct system the current passes directly from the dynamos to the motors on the cars. In the storage system the current charges the battery, and the battery is in turn discharged into the motors. Upon the loss thus entailed no reliable figures have been given. It is admitted, however, to be about 35 per cent. Against these losses of the storage system are to be placed the loss in the direct system, which ensues from the passage of the current from the main dynamo through the conductors on its way to the motors, and also from the leakage of the conductors themselves. The latter element is so small that it may be neglected entirely. The consumption of energy in the conductors is also very small—less than 5 per cent.—and by increasing the size of the conductors it may be reduced much below that figure. But, in any case, beyond possibility of denial, the operating expenses of a storage battery car for power alone must be at least substantially double those of a direct-system car.

In the use of a storage battery plant there are several items of expense yet to be added which it is somewhat difficult to state in figures, as no reliable data have yet been obtained from the limited experiments thus far made. It is evident that several tons of batteries must be lifted into and out of each car two or three times day, and a considerable force of men must be kept for this purpose. There are at least 19 plates in each accumulator of the type most prominently before the public—in the car mentioned above, 120 accumulators are used. There must be, therefore, on every car, 2,280 battery plates. In

practice these plates must be carefully inspected at every charging, the loose material upon them brushed off, connections tested, and all doubtful plates removed and replaced by others. This process must also require a large number of men. The charging of the batteries must be done under careful electrical supervision.

The depreciation of the batteries is confessedly very great; 12,500 miles are officially given as the life of a battery plate. Now, for an electric car, 100 miles per day is not an excessive mileage, so that the battery must be renewed wholly or in part every 125 days, or three times per year—a depreciation of 200 per cent. at least.

All of these combine to make the running expenses of the storage battery system many times as great as those of the direct system.

The first cost of a conduit system depends upon the relation between the length of line and the number of cars run. Taking a well-known road in Boston, which has 700 cars and 70 miles of track, we have ten cars to the mile—a fair average for the roads in our large cities. A conduit with conductors costs about 20,000dols. per mile, or 2,000dols. per car. In a comparison, the cost of the conduit per car must be balanced against the cost of the storage battery per car. Taking the price-list of one of the prominent storage battery companies as issued in Jan., 1888, it appears that accumulators of the "standard" type, in quantities over 10, cost 13dols. each. If the 120 accumulators carried by the car now running in New York city are of this type, one set costs 1,560dols.; and, as at least two sets are necessary, the total battery cost for a car would be at least 3,120dols. According to the price-list above quoted, 160 accumulators of the said "standard" type, costing 13dols. each, and weighing 32lb. each, will only give 5 h.p. for eight hours, a very moderate average power for a car weighing 6½ tons. It is, therefore, probable that where 120 accumulators only are used, they are of the kind known as "Type E," which cost 19dols. each, or 2,280dols. per set of 120, 4,560dols. for two sets. (The weight and price in quantities of "Type E" are not given.) Were the "standard" type employed, the weight per set would necessarily be 5,120lb., the cost per set 2,080dols., and for two sets 4,160dols.

These figures are to be balanced against the cost of conduit, which is 2,000dols. per car.

Where an elevated system of electrical conductors can be employed, the comparison is vastly more unfavourable to the battery, as the cost of the best overhead line is about one-tenth the cost of conduit.

It must be noted that in the above calculation the cost of strengthening and stiffening the car to carry from two to three tons added weight and of the extra motor needed to move that weight are not considered. There is, moreover, to be charged against the battery system the fact that a central station of at least twice the capacity is necessary. Not only must there be twice the engine power and twice the dynamo power, but the space occupied by the cars and battery must also be double, since there must be for each car a space both for loading and unloading the battery. This doubling up of boiler, engine, dynamo, and storage capacity is of special importance where the central station is located upon city property.

A storage battery is formed by placing two thin metallic plates, coated with a low oxide of lead, in a cell of diluted sulphuric acid. This battery is charged by passing an electric current through it, which decomposes the acidulated water into oxygen and hydrogen. These gases attack the two plates respectively, reducing one to metallic lead, and raising the other to a higher oxide of lead. When in this condition, the two plates correspond to the zinc and carbon elements of a primary battery and have an E.M.F. of some two volts between them. A current is then given out, which continues until the plates return to their original condition, and must be again recharged. The storage battery has, therefore, all the well-known inconveniences which pertain to the primary battery, and anyone who has dealt with a single primary battery can well imagine the difficulties attendant upon the task of carrying some 1,200 of them (there are 2,280 or more plates in 120 accumulators) upon a street car, taking them in and out several times a day. The rapid deterioration of the battery arises from the constant oxidation and deoxidisation which takes place; the base plate, which supports the active material (the oxide of lead), is quickly attacked by the nascent oxygen—gold and platinum being the only metals which will withstand it. The constant change in the chemical structure causes the base plate and its coating of oxide to expand unequally, so that the latter is quickly loosened and drops off, or, worse still, buckles outward until it touches the opposite plate, thereby short-circuiting the whole accumulator. It is then at once ruined by the heavy current passing through it. Again, from the presence of sulphuric acid in the battery a sulphate of lead is formed on the plates, which is a non-conductor of electricity, and gradually insulates each plate, thereby destroying its usefulness.

These are the main difficulties inherent in the storage battery. Substantially, no progress has been made in overcoming them, and it seems very likely that the storage battery

will take its place beside the primary battery as a generator of electricity having a useful but very limited field. There seems to be, in fact, no precedent in mechanics for the practical generation of large amounts of energy from the chemical combination of acids and metals such as takes place in both forms of battery.

COMPANIES' MEETINGS.

EXETER ELECTRIC LIGHT COMPANY.

The first annual general meeting of the Directors of this Company has been held at the Athenæum, Bedford-circus, Exeter. The chair was occupied by Mr. W. H. Ellis (chairman of Directors), and there were also present Messrs. L. J. Kennaway, H. G. Massingham (Managing Director), C. J. B. Sanders, E. E. Brand, R. P. Bishop, J. Knill (auditor), and H. W. Michelmore (secretary).

The Chairman, in moving the adoption of the report, which has already been published, said they must all feel exceedingly glad, after the difficulties they had gone through, to find that the Company had been so well and successfully established. That it would be successful in every respect he had not the slightest doubt; but what he should particularly like to call attention to was the desirability of the establishment of such companies in reference to health. This was a matter, no doubt, of the greatest importance, and they knew perfectly well that rooms lighted by oil, candles, and gas, and not properly ventilated, must be injurious to health. That being the case, he was sure they would all join with him in heartfelt satisfaction at the Company being fairly, and he sincerely believed firmly, established in the city of Exeter. Their prospects were of the very best. They had already had many arc lights applied for, and at least 1,000 incandescent lamps for internal use. This, however, was nothing as compared with what they expected to get; in fact, since the report was published they had had a great number of orders for lamps besides those referred to in the report. It was only a question of capital. He believed they had got as many orders for lamps as they could execute, and it was desirable that shareholders should assist in obtaining more capital, and in inducing their friends and the public to join the Company. He believed the day would come when every household would be desirous of having the electric light and so get rid of the horrible nuisance of burning oil and gas in living rooms. It was the intention of the Directors to issue a fresh circular asking people to join, so that with more capital they might have the means of extending the supply of light. He would confidently appeal to the public to do so, even their friends in the gas company, for the latter might with advantage take shares in the Electric Light Company. He did not think for a moment that the electric light was going to injure the dividends of the Gas Company. He believed there was such a field for the use of gas, as well as electricity, that the more the electric light was used the more would be the demand for gas. As years went on the cry would be for "more light," and instead of being losers, gas companies as well as themselves would be gainers. He trusted that the shareholders and the public would respond in such a manner as to enable the Company to supply the large field before them—namely, not only the houses in the City, but those in the suburbs and the surrounding districts.

Mr. Massingham seconded. He endorsed the remarks of the Chairman on the question of the electric light in relation to health. The electric light was certainly worth considerably more than either candle, oil, or gas, and the price at which they proposed to supply it would, he thought, compare very favourably with that of other illuminations. He also agreed with the Chairman that there was plenty of room for both the Electric Light and Gas Companies, in proof of which he instanced Taunton, where the electric light was introduced four years ago, and where, instead of injuring the Gas Company, it had created a demand for better gas lighting, and more of it. The result was that since the introduction of the electric light the Gas Company had sold more gas than at any previous period during their existence, and at the present time one of the shareholders of the gas company there was a Director of the Electric Light Company. He was quite confident that the unnecessary alarm that was first felt in Exeter would prove groundless. There was no more chance of the electric light doing away with gas than of the steam-engine doing away with horses. With regard to the price, with the exceptions of Taunton and Bath, the electric light would be supplied in Exeter at a lower price than in any other city in the Kingdom; and, so far as his knowledge went, lower than on the Continent or America. In London the prices averaged, he believed, about 100 per cent. more than the price they (the Exeter Company) charged, whilst, taking the provinces, Eastbourne, Brighton, and Hastings averaged 200 per cent. more than they were charging at Exeter. They had started in Exeter on a totally different footing to the speculative companies which had been established in some places. It was started with a comparatively small capital, which they hoped gradually to increase as the business extended. He thought they had a very bright future before them. They were progressing as rapidly with their work as possible, and he hoped that before the winter commenced they would be able to supply the light at a price which would commend itself to the general public.

The report was unanimously adopted.

The Secretary pointed out that while the Company would prove a benefit to the city on the score of health, it would also be a financial success, and pay substantial dividends.

Mr. Massingham added that in the case of the Taunton Company a share had never passed hands at less than par, and at the present time they were rapidly changing hands at 5 per cent. premium.

On the motion of **Mr. Knill**, seconded by **Mr. Bishop**, a vote of thanks was accorded the chairman of Directors.

A similar compliment having been paid **Mr. Massingham** and the secretary, the meeting terminated.

EASTERN TELEGRAPH COMPANY.

The thirty-fourth half-yearly ordinary general meeting of the Eastern Telegraph Company, Limited, was held on Thursday in last week, at Winchester House, Old Broad-street, Sir John Pender presiding.

The **Chairman** stated that the revenue received from messages during the half-year ended March 31 last was £352,791, or £28,647 more than the amount received in the same period of 1888. About two-thirds of the increase arose from their South African traffic and through political disturbances at Zanzibar. In concert with the Eastern and South African Company they had organised a complete system of telegraphy as an alternative system from the Cape on the West Coast. The growth of traffic referred to had enabled the Eastern and South African Company to pay a largely increased bonus. The shares of that company were all but entirely held by the Eastern Company, and their revenue account showed that they had received a return on their investment in that company of £79,650, against £31,200 in the corresponding period of the previous year. Their Egyptian traffic, which had been steadily declining for some years, showed an increase for the past six months. The Indian traffic alone exhibited a substantial decrease. This falling off, which amounted to £5,550 in the past half-year, was engaging their serious attention. Their dividend from the Black Sea Telegraph Company was the same, but on their investment in the Direct Spanish Telegraph Company they had received £184 less. The gross revenue from all sources for the half-year had been £435,932, or £76,226 more than in the corresponding period of 1888. The total working expenses for the half-year had been £92,448, or £5,314 more. The increase of £5,759 in the working expenses at stations was owing in great measure to the augmentation in the number of their foreign staff through the opening of the triplicate cable from Portcurnow, Lisbon, Gibraltar, and Malta, and the extension to Zante, on which the duplex system was worked, and to the opening of the station at Cadiz, they having put the latter place in telegraphic communication with Villa Real and Gibraltar. It had also been necessary to augment their staff at other stations, and to meet the requirements of the traffic they had found it necessary to add to the accommodation of several of their stations. The repairs to cables in the past six months had cost £48,665, or £10,253 more than in the same period of 1888. The expenses of five ships were included in the half-year under review (against four in the corresponding half of the previous year), as well as the cost of 203 knots of cable used on repairs and renewals. The total increase in this revenue had enabled them to meet the additional expenses incurred during the half year, and to pay an extra $\frac{1}{2}$ per cent. bonus on the ordinary shares, including the 20,000 additional shares issued to enable them to take up a like number of ordinary shares of the Eastern and South African Company. They had placed £118,000 to the general reserve fund, against £75,000 last year; and the fund now amounted to just over £500,000. They had also expended on their property, out of revenue and reserves, £782,383. During the last 15 years the traffic of the Company had increased by 370 per cent., but the income had increased by not more than 100 per cent. That was owing to the cleverness of merchants in adopting codes. Notwithstanding the very encouraging prospects and the solid position of the Company, they had a great deal of work before them; and while they wanted to increase their capital as little as possible, they must be provided with new cables to take the place of old ones when they died out. If, too, the traffic increased, as they expected, to Australia and other parts, they would require to lay down another cable, to give them perfect security and safety, not only between Aden and Bombay, but between Marseilles and Egypt. It would be their endeavour to maintain the same satisfactory dividend as that now proposed. He concluded by moving a resolution for the adoption of the report, the payment of the preference dividend, and the declaration of a dividend of 2s. 6d. and a bonus of 3s. a share, tax free, on the ordinary shares, making a total payment of $6\frac{1}{2}$ per cent. on those shares for the year ended March 31 last.

The **Marquis of Tweeddale** seconded the motion, which was adopted.

ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION.

An extraordinary general meeting of the Anglo-American Brush Electric Light Corporation, Limited, was held on Monday at the City Terminus Hotel to consider the resolutions, as given in our last issue, approving a proposed agreement between the Corporation and the Australasian Electric Light, Power, and Storage Company; winding up and reconstructing the Corporation; and authorising the liquidators to consent, if required, to the registration of a new company, to be named the Brush Electrical Engineering Company, Limited. The present subscribed capital of the Corporation is 52,314 shares of £5 each, or £261,570. Under the reconstruction the capital of the new company is to be £750,000, in 150,000 6 per cent. preference shares of £2 each and 150,000 ordinary shares of £3 each. The Falcon Company is to receive £65,500 in 11,100 preference shares and the same number of ordinary shares; and the Australasian Company is to receive £45,500 in 9,100 preference shares and a like number of ordinary shares.

Lord Thurlow, who presided, stated that the proposals submitted to the shareholders had been arrived at as the result of a great deal of care and deliberation on the part of the Directors, who believed

that, if adopted, they would greatly advance the interests of the shareholders. He was thankful to say that the litigation with the Edison and Swan Company, which had caused great anxiety for two or three years, was at an end, there having been a great deal in the nature of compromise on both sides. The valuable patents of Mr. Lane Fox would not only be maintained, but the Edison and Swan Company would take a license under them and recognise their validity; and on their part the Corporation would give up manufacturing lamps. They would obtain from the Edison and Swan Company lamps on the most preferential terms, and that company would pay them a royalty which would be an appreciable item in the annual receipts of the Corporation. The other litigation that was pending had reference to the compound winding of dynamos, but that was comparatively a trifling matter. The opinion of the English Court in this suit was in favour of the Corporation, but in the Scotch Court it was against them, and they had decided on appealing to the House of Lords. The proposals now before the shareholders included the reconstruction of the Company—a measure rendered necessary by the fact that their memorandum of association was not wide enough to enable them to embark on engineering business. The acquisition of the works of the Falcon Company would provide the additional manufacturing premises required by the Corporation, and would enable them to make for themselves the engines, etc., which they wanted, and thus do away with the middleman's profit. For each share now held in the Corporation they proposed to issue a preference share of £2 and an ordinary share of £3. With reference to the proposed amalgamation with the Australasian Company, the proceeding was a wise one, and the terms which had been provisionally agreed upon were favourable to both parties. If the resolutions before the meeting were passed, he felt that the future of the Company was practically assured. He was able to tell them, from the proxies which had been sent in, that a very large majority of the shareholders not only agreed, but cordially agreed with the policy which the Directors were now recommending.

A short discussion followed, in the course of which **Mr. Lane Fox** desired it to be understood that he did not consider himself bound by the agreement or compromise which the Corporation had made with the Edison and Swan Company. He regarded the incandescent lamp as a matter of vital importance to the progress and welfare of the electrical industry, and held that it would be a serious disadvantage to the prospects of the industry if the manufacture of the lamps were in the hands of any one company. As soon as he had the opportunity he intended to start manufacturing the lamps himself.

The **Chairman**, in reply, stated that no apprehension need be felt as to the Directors issuing the remaining shares at a discount. It would, in fact, be illegal to do so. The Australasian Company would be taken over with a sworn statement of its liabilities and assets, and the assets largely exceeded the liabilities. He could not state exactly the costs of the litigation in which they had been engaged, but they would not exceed the provision made for them in their last balance-sheet. He feared he could never hope to be quite in unison with Mr. Lane Fox. It was quite open to that gentleman to establish a lamp factory of his own, but he would venture to advise him rather to approach the Edison and Swan Company and submit to them any grievance he might have. The price to be paid for the Falcon works represented nothing like the expenditure which had been made on them in the last five or six years; and it was to be remembered that the price was to be paid in shares of the Corporation. He hoped that the unissued capital would be placed at a premium.

On the motion of the **Chairman**, resolutions were then passed *seriatim* in accordance with the objects of the meeting.

AUSTRALASIAN ELECTRIC LIGHT COMPANY.

An extraordinary general meeting of the Australasian Electric Light Power and Storage Company, Limited, was held on Tuesday, at the offices, 39, Coleman-street, E.C., to consider a proposed sale of the property and assets of the Company to the Anglo-American Brush Electric Light Corporation, Limited.

Mr. B. H. Von Tromp (the chairman of the Company) said that in the last two or three years it had become manifest that what was wanted to make the Company a success, and to push the patents in the Australian and other colonies, was money. At the meeting held in 1887 he informed the shareholders as to the position of the Company, and several of them stated that they were willing to find their proportion of the new capital. The same question arose in 1888, and it was suggested that a committee of shareholders should be appointed to confer with the Board as to how some fresh capital might be raised. In January last, in pursuance of the suggestion made at the previous meeting, the Board prepared a scheme for the reconstruction of the Company and the raising of additional capital. That scheme was circulated amongst the shareholders, and he was obliged to confess that the result was not sufficiently satisfactory to justify its being carried out. In the absence of money, the Board were obliged to look round and see if they could find a partner who would help the Company to push their undertaking. They did so, and eventually came into communication with the Brush Company, who the day before had met and passed a resolution approving, in substance, of the scheme. Having regard to the position the Company occupied, it was the best thing they could do, considering that their assets were not sufficient to justify the spending of more money. They therefore felt it would be better to amalgamate with a company having a large capital, and bringing in new blood. They would, of course, partake of the prosperity of that company; they would hold £45,000 of the stock, and would share in the profits. He need not say with what feelings of disappointment the Board had felt, some nine or 10 months ago, how that, in the absence of money at their back, it was practically impossible to force a large business in any way. That being so, they had con-

sidered that the best thing they could do was to make this arrangement. Certain technical difficulties had arisen, but no doubt they would be surmounted, and he would, therefore, ask them to carry out the agreement with such modifications as might be considered desirable. The chairman concluded by proposing the necessary formal resolution.

Mr. Frederick Isaacs seconded the motion, which was agreed to *nem. con.*

A vote of thanks to the chairman and Directors closed the proceedings.

FALCON WORKS.

An extraordinary meeting of the Falcon Engine and Car Works, Limited, was held at the offices, 41, Coleman-street, on Tuesday. Mr. W. W. Duncan (chairman of the Company) presided.

The **Secretary** having read the notice convening the meeting,

The **Chairman** said: Gentlemen, I presume I may take it that you have read the circular which has been sent you convening this meeting, which is for the purpose of getting your consent to the sale of this Company, with all its assets and liabilities, to the Brush Electrical Engineering Company, which is a new company to be formed to embrace the well-known Anglo-American Brush Electric Light Corporation, this Company, and the Australasian Electric Light Company. The circular gives you the fullest possible information, so it will be unnecessary for me to take up much of your time. As I stated to you at our last general meeting, your Directors have for some considerable time been carefully and anxiously considering in what manner they could most usefully and advantageously extend the scope of the works and business of this undertaking. This policy has been dictated and, indeed, forced upon us by the fact that we found it impossible to keep our engineering department fully employed. Steam locomotives on tramways, especially in this country, have been lately to some extent in disfavour, and there has consequently been no extension of the system, and therefore an appreciably diminishing number of orders for tramway engines. Our car department has been kept fairly well in full work, but here again we have to meet with pretty severe competition, and all the large tramway companies now make their own cars. The necessity was therefore forced upon us to endeavour to embrace other work for which our factories were suitable, and we have for the last 18 months been diligently looking into various matters and businesses that have come under our observation with this object in view. In this manner we got into negotiation with the Brush Company, who were anxious to secure larger works, as their business was rapidly extending, and, moreover, they entertain the question of bringing the company into prominence in connection with electrical motive-power on tramways, which there is no doubt is now imminent. The negotiations have been proceeding for some time, and have resulted in the scheme which is now before you, and which we have the greatest confidence in recommending you to adopt. We conscientiously believe that the terms offered are the best and most desirable which we could reasonably expect to obtain, while at the same time we consider that, the works being suitable for the business of the Brush Company, they get full value in their purchase, as it will be remembered that we bought them from the liquidator of the Hughes Company on a strict valuation. I would point out to you, as I did at the last general meeting, that if we were to continue the works with the business as it is now, it would be absolutely necessary for us to ask you to supply additional working capital, and, taking that into consideration, we think you ought to look upon the bargain we have made for you as fairly equitable. At any rate, we have done the best we can for you, and it is now for you to decide whether you will take it or leave it. Personally, I may say I have great faith in the future of the new company in which you will, if you adopt this proposal, in future be shareholders. The old Brush Company has had a somewhat chequered career. Its £5 shares have been as high as £30 or £40, and as low as £2; they are now about 4½. It has gone through its years of infancy, and has suffered from many diseases, but it has gained very valuable experience, and has thoroughly established itself in the front rank of companies connected with electricity in all its branches, and I am firmly of opinion that those companies which have managed to live through and contend against the difficulties that have presented themselves in this enterprise are now about to reap a rich harvest. It may be argued by some of you that we are about to hand you over to a non-dividend-paying company; this is true in fact, but the only reason why the Brush Company did not pay a dividend last year was in consequence of a legal action which was hanging over it, and which has since been settled. The earnings of the company for 1888 were £12,885, or sufficient to pay a dividend of 5½ per cent. on its capital of £237,000, and the average yearly earnings of the past six years are £6,127. It will hereafter be called the Brush Electrical Engineering Company, and will occupy a strong financial position, have ample resources, and sufficient working capital for the development of its business in all its branches. It has, we believe, very brilliant prospects before it, not only in England, but, in consequence of the absorption of the Australasian Company, it will be able to extend its business in Australia, New Zealand, South Africa, and India, where there is undoubtedly a most promising and lucrative field for electrical lighting and electricity generally. I think you will admit that your Directors, in proposing this bargain to you, have disregarded all thought of what were their individual interests, as, of course, if you adopt the scheme they lose their position as Directors without any compensation; but they desire no credit for this, as they have only done what they considered they were bound to do as your trustees. We consider you are to be congratulated on the opportunity thus offered you of amalgamation with so powerful an undertaking as this new company will undoubtedly

become at no distant date. I may tell you that the Brush Company held a meeting of their shareholders yesterday to consider the proposals embracing this amalgamation, and they were unanimously accepted. I shall be glad to answer any questions you may desire to put to me.

In reply to questions,

The **Chairman** said that the negotiations had been pending some time. The whole business was to be transferred to the Brush Company, including, of course, all accrued profits of the Falcon Company, and it was not, therefore, in the power of the Directors to declare any dividend.

The **Rev. W. J. Stobart** stated that he was a shareholder in the Brush Company, and, although he had only received one dividend from that company, he was of opinion that their business was improving from year to year. He would like to see some addition to the Board of the Brush Company, and was of opinion that it would be an advantageous thing for both companies if the amalgamation was carried through. The Directors had no doubt as to the advantages of the scheme. As already stated, if they were to continue the business with the orders in tramway engines fast going to a vanishing point and with strong competitors in the car business, such as the North Metropolitan Tramways and other large manufacturing, it would be necessary to ask the shareholders for a large amount of working capital. They knew that with their present working capital considerable sums had from time to time to be expended on the works, which had been made more valuable, and no doubt this had had its influence on the offer from the Brush Company. He also was of opinion that there was an infinitely better prospect for shareholders in the future of electricity than in the future of steam locomotion or tramway extension, as people connected with tramways found that tramways in small provincial towns did not pay, while the large cities were now fully supplied. He formally proposed the resolutions.

Mr. Sanderson seconded.

The resolutions were carried.

The **Chairman** remarked that it was intended to nominate Mr. Sanderson to represent the shareholders on the Board of the new company.

Mr. Sanderson expressed his willingness to act, and after a few further remarks as to the distribution of the new shares, the meeting closed with a vote of thanks to the Directors and officers of the Company.

NEW COMPANIES REGISTERED.

Ruston, Proctor, and Co.—Registered by Grundy, Kershaw and Co., 19, Southampton-buildings, W.C., with a capital of £250,000 in £10 shares. Object: to acquire upon the terms of an agreement expressed to be made between the North of England Trustee, Debenture, and Assets Corporation, Limited, and the Debenture Corporation, Limited, of the one part, and R. Bratten, as trustee on behalf of the company, of the other part, the business, up to the formation of the company, carried on by J. Ruston, at Lincoln and elsewhere, under the style of Ruston, Proctor, and Co., with property held or owned by J. Ruston in connection with the business; to carry on the business of agricultural and general engineers machine and implement makers, waggon tool makers, mechanical engineers, &c. The first subscribers are:

	Shares.
J. Ruston, Monks Manor, Lincoln	1
G. M. Hutton, Gate Barton, Gainsborough	1
A. E. Tyler, 117, Leadenhall-street, E.C.	1
T. T. Tweed, Town Clerk's Office, Lincoln	1
J. Mosley, 104, King-street, Manchester	1
R. F. Allured, 104, King-street, Manchester ..	1
T. Fry, M.P., Woodbark, Darlington	1

There shall not be less than three nor more than five Directors. Qualification, £1,000 stock. The first are J. Ruston, T. Fry, M.P., G. M. Hutton, and A. E. Tyler. J. Ruston does not join the board till after allotment. Remuneration to be determined in general meeting.

Woodhouse and Rawson United, Limited.—This Company has been formed to acquire and amalgamate the business of Woodhouse and Rawson, Limited, engineers and electrical contractors, and to unite with it the businesses of Woodhouse and Rawson Electric Supply Company of Great Britain, Limited; Woodhouse and Rawson Electric Manufacturing Company, Limited; Woodhouse and Rawson Electric Contract and Maintenance Company, Limited; and Charles L. Baker and Co., Limited, of Cornbrook Works, Manchester. The share capital of the Company is £350,000, divided into 40,000 ordinary shares of £5 each, and 30,000 seven per cent. cumulative preference shares of £5 each, together with £100,000 six per cent. debentures. It is stated that 15,700 ordinary and preference shares have been applied for by the directors and their friends. According to the prospectus the profits of the business of Woodhouse and Rawson, Limited, for the year ending June 30, 1888, as shown by the audited balance-sheet, were £21,440, and dividends at the rate of 12 per cent. per annum were paid for the year. It is stated that there has not yet been time to audit the accounts for the year just ended, but the profits are estimated at over £75,000, and by the terms of the agreement with Woodhouse and Rawson, Limited, this sum is to be deposited with this Company for three years as a dividend guarantee fund, towards ensuring the payment of a minimum dividend of 15 per cent. on the ordinary shares, after payment of interest on the debentures and preference shares for the above period. The company has been registered by Johnson, Budd, and Johnson, 24, Austinfrirs, E.C., with a capital of £350,000 in 30,000 preference and 40,000 ordinary shares of £5 each.

Object: to acquire, take over, and amalgamate the following businesses, and to develop the same: (a) Woodhouse and Rawson, Limited; (b) Woodhouse and Rawson Electric Supply Company of Great Britain, Limited; (c) Woodhouse and Rawson Electric Manufacturing Company, Limited; (d) Woodhouse and Rawson Electric Contract and Maintenance Company, Limited; (e) C. L. Baker and Co., Limited; any rights, trademarks, licenses, inventions, plant, stock-in-trade, and the freehold premises known as the West Kensington Hall Estate, including the factories and buildings thereon; to carry on the business of an electrical supply and manufacturing company. The first subscribers are:

	Shares.
Lord Aberdare, P.C., Duffryn	1
P. Rendson, Woodhurst, Crawley	1
Sir T. Farrer, Bart., Abinger, Dorking	1
Lieutenant-General Sir J. Stokes, K.C.B., Good Rest, Hayward's Heath	1
Sir J. Coode, K.C.M.G., 35, Norfolk-square, W.	1
A. J. L. Capport, K.C.I.E., 11, St. Georges-terrace, S.W.	1
C. C. H. Vincent, C.B., 1, Grosvenor-square	1
F. L. Rawson, 68, Cornwall-gardens, S.W.	1

There shall not be less than three nor more than nine Directors. The first to be appointed by the subscribers to the memorandum of association. Qualification, 50 shares. Remuneration to be determined in general meeting.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The traffic receipts for the week ended July 19 amounted to £4,167.

Western and Brazilian Telegraph Company, Limited.—The receipts for the week ended July 19, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,680.

Cuba Submarine Telegraph Company, Limited.—This Company recommend, after providing for the dividend on the preference shares and placing £6,000 to the reserve fund, a dividend on the ordinary shares at the rate of 9 per cent. per annum, tax free, leaving £345 to be carried forward.

Direct United States Cable Company.—The report of the Directors of this Company for the six months ended June 30, states that the half-year's revenue, still subject to revision, including income-tax refunded, and after deducting out payments, amounted to £39,626, against £17,507, after similar deductions. The working and other expenses, including income-tax, but exclusive of cost of repairs of cable, amounted to £16,676. The quarterly interim dividends of 2s. per share for the quarter ended the 30th of September, and of 3s. 6d. each per share for the quarters ended the 31st December, and the 31st March, were paid during the financial year, and a final payment of 3s. 6d. per share is proposed, making, with the three interim dividends, 3½ per cent. for the year. The balance of £2,719 is carried forward.

The Anglo-American Telegraph Company, Limited, in their report, state that the total receipts from January 1 to June 30, including the estimated balance of £1,325 brought forward, are estimated at £144,992. This amount, however, is subject to revision, dependent upon the result of the law suit still pending between this Company and the Paris and New York Telegraph Company. The traffic receipts show an increase of £68,264, consequent upon the increase of tariff from 6d. to 1s. per word, which came into force on September 1, 1888. The total expenses, including repair of cables, etc., amounted to £46,277. One quarterly interim dividend of 12s. 6d. per cent. on the ordinary and of 25s. per cent. on the preferred stocks was paid on May 1, and a second quarterly dividend of 15s. per cent. on the ordinary and £1. 10s. per cent. on the preferred stocks will be paid on August 1, absorbing £52,500, and leaving £2,465 to be carried forward.

PROVISIONAL PATENTS, 1889.

JULY 15.

11315. **An electric motor arc lamp.** Amos William Richardson, 279, Stretford-road, Manchester.
11316. **Preventions of accidents at sea, called the "Marine telegraph."** Samuel John Browning, 74, High-street, Portsmouth, and Benjamin Nicholson, Gosport, Hampshire.
11317. **A method of and apparatus for controlling steam and gas engines by means of electricity.** Harry Whiteside-Cook, Stondon-Massey, Essex.
11328. **Improved grids or supporting frames of electric accumulators.** Erich Correns, 89, Chancery-lane, London. (Complete specification.)
11332. **Improvements in and in the materials used in the manufacture of brushes and commutators of dynamo-machines, in part applicable to bearing surfaces generally.** Killingworth William Hedges, 8, Quality-court, London.
11341. **Improvements in recording apparatus for electric meters.** George Washington Walker and William Bracken, 1, Queen Victoria-street, London. (Complete specification.)

JULY 16.

11419. **Improvements in electric meters.** Siemens Brothers and Co., Limited, 28, Southampton-buildings, London. (Firm of Siemens and Halske, Berlin.)
11422. **Improvements in and relating to bulbs or globes for incandescent electric lamps.** Thomas George Litchfield, 45, Southampton-buildings, London.
11425. **Improvements in regulating apparatus for electric arc light lamps.** Emil Fischinger, 6, Bream's-buildings, London.
11426. **Improvements in the mode of driving, by means of electric motors, tram-car and other mechanism, and in apparatus for reducing in transmission the speed of rotation derived from electric and other motors.** Philip Arthur Newton, 6, Bream's-buildings, Middlesex. (William Main, United States.) (Complete specification.)
11429. **Improvements in the manufacture of electric lamps.** Philip Middleton Justice, 55 and 56, Chancery-lane, Middlesex. (James Clegg, United States.)
11430. **Improvements in electrodes or filaments for electric lamps.** Philip Middleton Justice, 55 and 56, Chancery-lane, Middlesex. (James Clegg, United States.)

JULY 17.

11471. **Improvements in electric accumulators or storage batteries.** Emile Nicolas Reynier, 28, Southampton-buildings, London.

JULY 18.

11519. **Improvements in roses for supporting electric lamps.** Charles William Farquhar and Henry Lewis Doulton, Lambeth.

JULY 19.

11528. **Improvements in electrode plates for electric accumulators.** Carl Beyer and Gottfried Hagen, 46, Lincoln's Inn-fields, London.
11574. **Improvements in and connected with insulators, electrical conductors, and conduits for same, partly applicable for telpherage and other electric lines.** William John Lawrence Hamilton, 77, Chancery-lane, London.

JULY 20.

11581. **Improvements in electrical alarms.** Norelliffe George Thompson, 13, Victoria-street, Westminster, London.
11589. **Improvements in electric conductors, and in laying and supporting conductors within conduits.** Rookes Evelyn Bell Crompton, 55 and 56, Chancery-lane, London.
11590. **Improvements in primary batteries.** Frederick King and William Phillips Mendham, The Western Electrical Works, Narrow Wine-street, Bristol.
11615. **Improvements in conduits and rails for electrical and other railways.** Frederick Holly Reed and George Nicholas McKibbin, 191, Fleet-street, London.

SPECIFICATIONS PUBLISHED

1888.

9745. **Electric motors.** Manville. 8d.
11100. **Electric vehicles.** Kincaid. 8d.
11106. **Electrical signalling-apparatus.** Lake (Davis and Welch) 11d.
11570. **Electric arc lamps.** Pieper. 8d.
12163. **Electric batteries.** Serrin. 11d.
12452. **Electric locomotives.** Sandron. 6d.
13215. **Electric batteries.** Clark (Maiche). 4d.
13987. **Electric arc lighting.** Saunderson. 6d.
15648. **Electric switches.** Cleveland. 81.
18754. **Galvanic batteries.** Dymond (Gassner). 4d.

1889.

7597. **Dry galvanic cells.** Mehner. 4d.
8255. **Galvanizing metals, &c.** Midgley and Nye. 6d.
8730. **Printing telegraphs.** Clark (Johnson). 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price Wednes- day
12 Feb.	1/2	Anglo-American Brush E.L.	—	—
12 Feb.	2/0	— fully paid	—	—
14 Nov.	0/4½	Con Telephone & Main ...	1	¾
27 July	10/0	India Rubber, G. P. & Tel.	10	19½xd.
.....	.....	House-to-House	4½	4½
30 May	2½%	Oriental Telephone	11	¾
.....	.....	London Electric Supply ...	5	3½
.....	.....	Swan United	3½	4½
12 July	12/0	Telegraph Construction ...	12	43
2 July	6/0	— 6%, 1889	100	105
29 Nov. ...	5/0	United Telephone	5	15½

NOTES.

Central Stations at Chicago.—Four new large central stations are in progress at Chicago under the superintendence of Prof. Barrett, the city electrician.

Kensington Town Hall.—Estimates are invited, as will be seen by the advertisement, for installing the electric light in the council chamber and vestry clerk's offices, at the Town Hall, Kensington.

The Acme Electric Men.—The annual dinner of the employes of the Acme Electric Works took place on Saturday, the 27th ult., at The Anchor Hotel, Knapp Hill, Woking, and a thoroughly pleasant day was enjoyed.

High-speed Electric Tramways.—At Wichita, Kansas, the Thomson-Houston electric railway is run by a 40 h.p. generator that has at times operated six heavy cars, all running at a schedule speed, which on certain parts of the road is fifteen miles an hour.

Photometry.—A book upon the measurement of light by Mr. W. J. Diddin, who recently read a paper before the Society of Arts on the same subject, has just been published, entitled "Practical Photometry: a Guide to the Study of the Measurement of Light."

Birmingham Exhibition.—The Electrical Exhibition at Bingley Hall, Birmingham, is open to-day, and our representative, Mr. J. T. Sprague, will be at the opening, of which we shall give an account next week. The whole exhibition will be described in due course.

Shanghai Contract.—The large contract for the Government House at Shanghai for all electrical fittings, brackets, switches, and other apparatus (with the exception of the very large electroliers for the hall) has been given to the General Electric Company (Messrs. Binswanger and Co.).

Thomson-Houston Electric Railway.—Orders for three more Westinghouse compound engines of 200 h.p. each have been given for the Omaha and Council Bluffs Electric Railway, making five in use in this plant. This is regarded as the model electric railway of the Thomson-Houston Company.

South London.—The Metropolitan Electric Supply Company have definitely abandoned the provisional order granted to them by the Board of Trade for the electric lighting of South London, under which they were empowered to supply with electric light the parishes of Lambeth, Streatham, and Clapham.

The Electric Sugar Fraud.—The Birmingham magistrates on Friday investigated a very painful case of attempted suicide by a broker who had invested largely in electric sugar shares, and was ruined by the fraud. Finding himself utterly destitute, he tried to fling himself into a furnace, but was rescued after having sustained serious injuries to his head. He afterwards nearly succeeded in cutting his throat, but is now recovering.

Finsbury College.—The programme for the session 1889-90 of the City and Guilds' Technical College, Finsbury, has just been issued, and contains a large amount of information as to the classes and work undertaken at the college under the superintendence of Prof. Silvanus Thompson. Those who intend, or have to advise youths

who intend, to enter for a course of technical education should most certainly procure this programme.

Overhead Wires.—A letter has been addressed to Mr. Courtenay Boyle, of the Board of Trade, by the London Chamber of Commerce, asking for certain modifications in the regulations for overhead wires, which have received the careful attention of a special committee. It has not been considered necessary to trouble the President with a deputation. Details need not be given, as the regulations themselves have not yet been published.

Electric Underground Railway for New York.—Mayor Grant is reported hard at work on plans for securing an underground electric railway for the city of New York. He favours a scheme for the formation of a City Railway company which shall purchase the right of way straight through the streets and buildings, build a road on a solid foundation just beneath the surface, and erect a superstructure of fire-proof buildings over the railway, with stations at suitable intervals.

Dublin.—The Dublin Corporation have given notice of their intention to apply to the Board of Trade for a license to supply electric lighting for private purposes. The advertisements to that effect appear in the local papers of the 25th July, and it is intimated that any opposition to the scheme may be lodged with the Board of Trade within two months from that date. It will be in the memory of our readers that the Dublin Corporation have already obtained a license for the public lighting of the city.

Edinburgh.—The arrangements in connection with the forthcoming Electrical Engineering Exhibition are progressing satisfactorily. The question of the site has been practically settled—Meggatland, it is understood, being the locality fixed upon. Both the North British and the Caledonian Railway Companies have agreed to lend every assistance possible in the carrying out of the undertaking, and it is expected that the latter company will establish a siding for goods traffic. The guarantee fund has met with a gratifying amount of success since it was opened two or three days ago.

Racing Telegraphy.—The following statistics of a three days' race meeting at Leicester have been published, and will show how large a share sports have in contributing to telegraphic finance. Dealing, in the first instance, with the central office, it appears that 5,145 ordinary racing and 203 "press" messages were forwarded, while 711 messages were received. On the racecourse 5,389 general and 341 "press" messages were forwarded, and 2,260 received, the totals thus being: Received 2,971, forwarded 11,078, or a grand total of 14,049 messages. These represent in words: At the central office 39,795, on the course 10,921, or a grand total of 50,716 words. The foregoing figures relate simply to "tipsters'" and other racing telegrams, and are altogether distinct from other messages.

Art Workmanship Prizes.—The Society of Arts offers £150 in prizes for objects at the Arts and Crafts Exhibition this autumn. Of these some are to be given for metal work, wrought iron, brass and copper repoussé, gold and silversmiths' work, and chasing. The prizes will be awarded to craftsmen, not professional artists, and may be the work of one or several workmen in combination, and need not be the property of the person sending them in; or they may be exhibited by the manufacturers on behalf of the workmen. This is a department of art which is receiving

constantly increasing attention at the hands of electrical engineers, and some of our artistic fitting makers may like to send in specimens of their men's best work. Forms of application can be obtained of Mr. Ernest Radford, secretary of the Arts and Crafts Exhibition Society, at the office, 44, Great Marlborough-street, W.

General Electric Company.—This well-known general supply company has just been registered as a limited liability company, the businesses which have been carried on in London and Manchester under the styles of the General Electric Co. (G. Binswanger and Co.), London, and the Manchester Electric Works Co., Manchester, having been combined under one name. The name of the new company is the General Electric Company, Limited, of London and Manchester (G. Binswanger, managing director). The head office will be at 71, Queen Victoria-street, London, E.C., and the works at Chapel-street, Salford, Manchester. The company, however, we understand, will not come before the public, but will continue to be a private concern, the amalgamation having been effected to enable them to cope successfully with the increasing demand for their manufactures. The management remains unaltered, as Mr. G. Binswanger is managing director, supported by two co-directors, Mr. Max Binswanger and Mr. H. Hirst, both of whom have, for many years, been at the head of their electric bell and electric lighting departments. We wish the new company all the success they deserve in their new departure. The demand for continued extension is a good sign of the steady progress of electrical business.

Chelmsford.—The preparations for lighting the borough with electricity are being carried forward, work in running the wires having been commenced last week; and it is hoped that Messrs. Crompton will be able to commence their contract in September. The main thoroughfare will be illuminated by 18 arc lamps of 1,000 nominal c.p. For the remaining portions of the town there will be 200 incandescent lamps of 32 c.p. nominal, or more than twice the power of the present gas lamps, which are nominally of 12 c.p. each. The incandescent lamps are to be fixed in lanterns, which will hang from brackets about 15ft. to 20ft. high. The lamps will be suspended between poles, about 25ft. high; many of these have already been put up, and in the other cases the iron sockets, which are about 6ft. high, are being fixed for their reception. The wires will be carried overhead at the height of about 25ft., and the copper ones will all be covered with vulcanised indiarubber. The generating station is being built under the new offices of the company at the works, and the foundation for the machines has been laid some time. The engine is 140 h.p., and part of the power will be available for private lighting. The engines and dynamos will be duplicated to guard against any breakdown. Alternating currents and transformers will be used.

The Westinghouse Amalgamation.—With regard to the plans for consolidating the Westinghouse electrical interests, the following special dispatch from Pittsburgh of July 11 gives the latest details: "The stockholders of the Westinghouse Electric Company at a meeting to-day decided to reorganise under the name and charter of the Westinghouse Electric and Manufacturing Company. In order to do this, Mr. George Westinghouse secured, by purchase of a majority of the stock, the charter of the Chartiers Improvement Company, an instrument granted by legislative enactment in 1871, which conferred upon the

corporation named extraordinary powers and privileges, such as have been impossible to secure under instruments of the same class granted by the State since the new constitution of Pennsylvania went into effect in 1874. The name of the Chartiers Company was changed last month. The charter is of the old-fashioned blanket order, empowering those operating under it to do any sort of business or manufacturing, with the exception of running a bank and issuing bank notes. All the electric companies now controlled by the Westinghouse Company will be consolidated as soon as possible and their field of operations extended, the last obstacle having been removed by to-day's action. The company is now doing a business of 12,000 dols. daily and employing 2,000 men. The certificates of the old company are to be exchanged for the new, share for share."

Government Telegraphs in America.—It is reported from Washington that Postmaster-General Wanamaker has struck a hard blow at the Western Union Telegraph Company by making a sweeping reduction in the tolls paid for Government messages. The statute which granted to the company the privilege of using military and post roads and crossing national land, stipulated that the company should carry Government messages at a rate to be fixed by the Postmaster-General. For twenty-three years the rate has been one cent a word. The matter has recently come before Postmaster-General Wanamaker, and he fixed the rate at one mill a word instead of one cent. This action has caused the Directors of the Western Union great dismay. The government's business is large, and the profits on it have, it is said, been a comfortable figure. The report is ascertained to be correct, and it by no means covers the ground of the Postmaster-General's notification. He informs the telegraph companies that under the authority conferred upon him by law he decided that the rates for Government messages day or night shall be one mill a word without regard to distance. There is no allowance for delivery, as stated in the New York publications. By those who have even the most general knowledge of telegraphy this order is recognised as one committing the Government to a demand that the telegraph companies shall do public business very much below actual cost, and very earnest protests are being made by those interested in the Western Union Company.

Electric Light in Sawmills.—Electric lighting plant has been fitted at Messrs. John Mitchell and Co.'s sawmills, Leith, by Messrs. King, Mendham, and Co., and in no part of the buildings is there now any necessity for gas or oil light. It is also proposed eventually to light the yard proper by means of arc lights. Incandescent lights are used, and comprise about 50 lamps of 16 c.p. The current for supplying these lamps is obtained from a small dynamo driven directly from the shop shafting. The dynamo runs at about 1,100 revolutions per minute, a speed with which sawmillers are quite familiar, and which is, in this case, obtained with the greatest ease. The dynamo, which is of Messrs. King, Brown, and Co.'s own manufacture, is compound wound. The dynamo has double brushes on each side of the commutator, by which arrangement it is possible to undertake long-continued running without interfering with the lighting, as the brushes can be altered and adjusted alternately. The dynamo is mounted on two planed iron sides with screw gear for taking up the slack in driving-belt. Taps are provided in the standards of the machine from which the spent oil may be drawn when required. The different fittings have been specially made for the different machines and the special positions

requiring them, fitted with reflectors for general lighting, or swung over the machines. Those under the machine in the shaving and sawdust pits are made dustproof, and especially strong, and give a splendid light in a position where it would be absolutely impossible to introduce a gas jet.

Statter Dynamos and Motors.—J. G. Statter and Co., of the Alliance Engineering Works, West Drayton, have sent us their new catalogue of dynamos and motors. Two types of machines are made and stocked; high-speed small-power dynamos for smaller installations are made with a single magnet coil, and with the armature low down to keep the centre of gravity low, and the larger dynamos are made with the double magnets. The list bears evidence that great attention is paid to the perfect mechanical design and workmanship of these dynamos, and all details seem to be well considered, so that intending users have it in their own hands to make this electric lighting a thorough practical success. Instances of success are given, one especially, where a mill-owner had his coal account carefully tested and could detect no increase in his coal bill, and his whole premises are lighted. Special high-speed automatic engines are mentioned, specially designed to run their dynamos, and combined plants, direct-driven, are also made specially for ship lighting and colonial work. Motors are made a special feature, self-regulating and absorbing power strictly proportional to the work done. They require little attention, and all details are arranged so that they can be put into the hands of a labourer to work. One of these motors is at present running in their works, at some of the dirtiest work possible—namely, driving a loam-mill for the foundry. The prices seem very small. They are made from $\frac{1}{4}$ -h.p. to 23 h.p., to run on standard circuits of from 50 to 110 volts.

Goodsall v. Pender.—We do not mean to indicate legal action by the juxtaposition of these two names, but the antagonism between Captain Goodsall and Sir John Pender at the meeting of the Eastern Telegraph Company. Captain Goodsall has a grievance, yet if we might advise we should say follow the example of "Brer Rabbit" and "lay low." No good will come of complaints at these meetings. Pender is too strong to be attacked in this manner. He comes to declare a dividend, and carries proxies in his pocket sufficient to swamp opposition. Then shareholders can only judge by what Captain Goodsall says and what Sir John Pender says—the truth is not the question—the one contradicts the other, and there is an end of it. We should have nothing to say in this matter except that Sir John Pender drew very largely upon his imagination when replying to Captain Goodsall about a contemporary paper. The facts are hardly as Sir J. Pender stated. The truth and his statement are somewhat different. There is no single statement of the whole that is accurate, and a greater distortion of facts it would be difficult to imagine. We never heard that as plain John Pender, or as Sir John Pender, the chairman of multiple companies posed as a philanthropist. Nor do we believe any action of his life tends to point to this belief. He is about as keen a man of business as "they make 'em," and does nothing unless he sees a prospective *quid pro quo*. His success in life shows how admirably he has managed all things he touched to his benefit, with, of course, now and again, slips that shall be nameless. Stronger men than Captain Goodsall, or the writer, are on the war-path, and any day may bring about such a convulsion in Old Broad-

street that will give a salutary lesson where it is much needed.

Reckenzaun Electric Meter.—A new and very ingenious practical meter for the measurement of electric currents was shown us a few days ago by Mr. Reckenzaun. This he has been engaged on for the last two years, and it is now perfect in working, but we are not able to give illustrations of it as yet, as the foreign patents are still to be obtained. The action, however, may be briefly mentioned. It depends upon the invention and simultaneous employment, a solenoid with an action perfectly proportional to the current strength, a self-starting clock mechanism, and an electric self-winding arrangement. To obtain a solenoid proportional in its motion has been a difficulty which has hitherto prevented this method being used. The difficulty is got over by Mr. Reckenzaun by employing two solenoids, in one of which a counterweight is simply held suspended, as it were, in the lines of force, and its action is simply to lessen the weight of the core, so that when the main solenoid acts on the lever the counter weight can be adjusted to compensate exactly, and the movement of the lever is strictly proportional to the current. The lever carries a small friction-pulley, which rises to the periphery, or falls to the centre of a constantly revolving friction-disc. This is kept in motion by the clock action, which is wound up one step by a shunt current from the lamp circuit every quarter minute, and the pendulum is arranged with a peculiar escapement as to be self-starting on the admission of the main current. The meter shown us was a 30-light meter for continuous currents, and is meant to be hermetically sealed, having dials to allow it to run without attention for three years, when they begin again at zero. Special contacts are made to avoid wearing by sparking. Similar meters will be made for alternating currents, and will, probably, before long be in the market. Some have been working in laboratories, both in England and America, for some considerable time, with very satisfactory results.

Agricultural Show at Wigan.—The annual show of the Royal Manchester, Liverpool, and North Lancashire Agricultural Society was held last week at Wigan. At this exhibition Messrs. Sydney Walker, Oliver, and Co., of Newcastle-on-Tyne, exhibited in a striking manner the rapid advances which have been made in the application of electricity to mining work during the last ten years. For more than that period this firm have given special attention to the requirements of mines, and they have studied to produce an apparatus that shall be strong enough for the work of a mine, and simple enough for the mining officials to handle without special training. They have fitted up over thirty collieries with electric light, the result being not only improved working, but considerable economies. They have also fitted some hundreds of their electric signals on the engine planes and in the winding shafts of collieries in all parts of the United Kingdom. In one of the Wigan Coal and Iron Company's pits, for instance, eight loud bells ring simultaneously at different stations in the mine and engine-houses, from any part of the hauling roads, by simply pressing two naked wires together. Working models of these signals, and of domestic electric bells, are exhibited, also various incandescent lamps from $2\frac{1}{2}$ c.p. to 1,500. The current for the latter is furnished by one of the firm's 100-light dynamos and is driven by a Marshall's engine, the same current being used to drive one of their 2 h.p. electric motors, which in its turn can be made

to drive another dynamo electric generator, whose current supplies some of the lamps on the stall, or the model fan exhibited by Messrs. Walker Bros. The firm have a very interesting display of switches, brackets, weather-proof protectors for outdoor lamps, together with electrical measuring instruments, the powerful bells and strong iron keys used in mines, and many other interesting things. Mr. G. Stephen Corlet, the firm's manager for the district, has superintended the erection of the apparatus, and Mr. Sydney F. Walker is also in attendance.

British Association Excursions.—A number of excursions have been arranged for the meeting of the British Association in Newcastle, nineteen in all, eight upon the first Saturday, in the afternoon, and eleven for Thursday following, for the whole day. The routes, railway and refreshment accommodations, guide-books, conductor and conveyances, have all been arranged for by the able and energetic secretary for the committee, Mr. Adolphus H. Dickinson, who has taken an immense amount of trouble to make this part of the programme a success. Each excursion is made to be self-supporting, the price charged for the ticket covering all expenses. As many of the local gentry, however, provide luncheon free to the members of the association visiting their places, the cost of these tickets is in many cases merely nominal. Offers of hospitality have been received from the Duke of Northumberland, Lord Armstrong, the Mayor and Corporation of Berwick, the Middlesbrough British Association Reception Committee, Earl of Carlisle, Colonel Mitford, Sir George Trevelyan, Bart., River Tyne Commissioners, John Daglish, the authorities of the University of Durham, and others. Altogether, the programme is a very inviting one, and will, no doubt, be well appreciated by those for whom it has been prepared.

City Lighting.—The Streets Committee of the Commissioners of Sewers on Tuesday reported on the contracts for the City lighting. It seems that five companies—the Anglo-American Brush, the Metropolitan, the London Electric, the Laing, Wharton, and Down, and the House-to-House—sent in tenders. Major Marindin had since, however, notified them that statutory powers would be necessary, and the first four of these companies mentioned had promised to apply for provisional orders next session. Only one, the Anglo-American Brush Company, were strictly in accordance with the model specification of the Board of Trade, and under the advice of Mr. Preece they instructed the officers to negotiate further with the Metropolitan Electric Supply Company and the London Electric Supply Company, with a view to arrange similar terms with them. This had since been done, with the result that they had severally modified the terms of their tenders, so as to bring them into uniformity with that of the Anglo-American Brush Company, and, broadly, all these three companies now agreed to accept the terms of the original specification modified only in terms of the provisional orders, and sanctioned by the House of Commons. The prices per annum per arc lamp were as follows: The London Electric Supply Corporation, £24. 3s. 10d.; the Metropolitan Electric Supply Company, £26; the Anglo-American Brush Company, £26; but the London Electric Supply Corporation proposed to extinguish half the lamps at midnight. After full consideration the committee recommended that the tenders of the said three companies be provisionally accepted, subject to their agreeing to enter into a contract for 21 years, determinable by either party at the end of seven or fourteen

years, and the London Electric Supply Company waiving the condition as to extinguishing half the lamps at midnight. That the three districts into which the City is divided for this purpose be allotted as follows—viz.: No. 1, west, to the Metropolitan Electric Supply Company; 2, central, Anglo-American Brush Company; 3, east, London Electric Supply Company. To light the main thoroughfares by means of 395 arc lamps would cost £10,024, in place of 1,730 gas lamps now costing £5,530 per annum, but whilst the price would not be double that of gas, the amount of light would be many times greater. An amendment was proposed that the report be printed, and circulated and its consideration adjourned, but this was negatived by the chairman's casting vote. The solicitor stated he was not quite aware of the terms Mr. Preece had arranged, and as a matter of fact all the tenders differed somewhat from the original conditions. Finally, the debate was adjourned without the report being ordered to be printed.

Charging Stations on the Thames.—Immisch's charging stations for electric launches on the Thames are looking quite resplendent now, and are a prominent object in some of the reaches. The other day we had a look over the one at Richmond, which has been there now about three weeks. It is a floating station, moored at Glover's Island, on the river, just below The Star and Garter, and is No. 1 of the series. It is a long, low craft, rather like an immense house-boat, consisting, in reality, of a large river barge, boarded round, and with windows and doors all nicely painted and finished up, and transformed, one sees, on looking inside, into an engine and dynamo-house, with just the top of a black funnel showing above. A large legend, telling all and sundry what the craft is, is carried in front in full view. The engine is a semi-portable 25 h.p. Fowler engine, running an Immisch dynamo of 125 volts and 120 amperes. Switches and fittings, of course, are arranged inside, and the long wires from the dynamo are curled up, ready to charge up any electric craft that may be stopping in Richmond. Berths are arranged for the electrician and the engineman, who, when we called, had nothing on hand in the way of supplying stored energy for pleasure trippers, and, in a neat peaked cap and sou'wester, was leisurely contemplating the running stream below, in regular *dolce far niente* style. There are five or six of these charging stations altogether, covering the course right up to Henley, and there are some ten or a dozen electric launches of sundry sizes which, on the higher reaches especially, are, we believe, very well patronised, their quietness and cleanliness being much appreciated. One of these charging stations—that at Hampton, where Mr. Volk, the engineer-in-chief, has his headquarters—is a pretty little artistically-built villa or river-house, and is a distinct gain in appearance to the waterside. We must congratulate Messrs. Immisch upon their success in this undertaking. It seems, however, rather a waste of plant to have engines and dynamos ready and only used occasionally; and where it was possible that permanent charging stations could be usefully employed as sources of light for the hotels, charging the launches also when desired, they would be doubly useful. Of course, floating stations are required for certain occasions, but even these might possibly be made doubly useful. Where wealthy people live in the summer months in house-boats, they would appreciate the electric light if they could get it easily, and if they were told that they could have a set of storage cells for their light, and the floating station would come round once a week or so and

charge them up for a regular fee, these also would serve their double purpose. We commend the idea to them with our respects.

Electric Traction for Underground Railways.—

A lecture on this subject was given in connection with the Scientific Society, in the hall of the Literary and Philosophical Society, on Wednesday week, by Mr. M. Holroyd Smith, who is a townsman of Halifax, and who is well known as one of the pioneers of this work. Dr. S. C. Smith was chairman. To make his lecture thoroughly understood by the audience, Mr. Smith prefaced it with some interesting remarks on electricity. Coming to its application to the trains on the underground lines in the metropolis, he said the force required to set those trains in motion was 600 h.p. The desire of nearly everybody outside the electrical world, and it was very unfortunate that it was so, was that they wanted electricity stored in a small bucket or handbox which would give them the force they wanted to some untold amount of energy. He had carefully gone into a calculation of what would be the necessary weight of the very best accumulator, or storage batteries, in order to produce that 600 h.p., and found it would require absolutely 200 tons of batteries, and that altogether disregarding the weight of the batteries themselves. He thought that statement was quite sufficient to show that if there was to be any success in working the underground lines in London by electricity, they must look to some other method of producing the power than storage power, and that naturally came to producing the power direct. How were they to get the power from the station to the train, especially when they had to deal with such enormous currents as were required to produce 600 h.p. ? Having touched on the mass of difficulties which arose as soon as they began to deal with this large question, Mr. Smith proceeded to show how he proposed gathering the current for the metropolitan lines. Electricity by means of a dynamo would be generated by a stationary steam-engine and conveyed along overhead conductors of a peculiar shape, a wire from these being taken to a motor in the car. He had constructed an instrument like that, and caused it to travel at a speed of 25 miles an hour, and through it passed a current to drive 600 h.p. Mr. Smith pointed out the advantages of his system as opposed to the present method. Firstly, it would be very much cheaper. The present cost of working the underground trains in London was about 10½d. per train mile. He was within safe limits when he said that might be done with electricity for less than 6d. per train mile. That arose from the fact that instead of having to carry the weight of the steam-engine, which weighed over 40 tons, and the coal and water, there was only a motor weighing between 2½ and 3 tons. The nasty sulphurous smell, which nearly choked the passengers through the tunnels, would be got rid of. There would be greater safety, because it would be possible to arrange that as soon as a train came within a certain distance of another the following train would lose the power to go forward, and thus danger of collision would be prevented. It would also be possible for all the doors to close automatically as soon as the train started. A vote of thanks to Mr. Smith for his exceedingly interesting lecture, proposed from the chair, was passed.

Electrical Execution.— Nemesis has overtaken Harold P. Brown in the shape of an ordeal under cross-examination in the case of Kremmler, the condemned criminal. Suit has been brought against the warden of Auburn prison to prevent the inflicting of the death penalty by electricity on the ground that it is "cruel and unusual" and

therefore prohibited by the American constitution. The question of fact that men have been killed by electricity was admitted: the question of cruelty is to be settled by testimony. Harold P. was called. He stated that he has been in the electrical business for 13 years, beginning in Chicago as an agent for the Edison Company. He then became general agent for the Western Electric Company for three years, and devised forms of electro-medical apparatus for physicians. For five years he was with the Brush Company as electrician and salesman, and for a time acted as engineer of a company working his own inventions. He now earns his living as an engineer designing new apparatus, testing electrical devices, and giving expert testimony. He is also qualified to earn his living as a mechanic. He did not hold a certificate from any institution, but was a self-made electrical expert. In answer to questions about his experiments on living bodies, he stated he measured the resistance by a Wheatstone bridge, but had never had the opportunity of measuring that of a man killed by electricity. He had made a list of 91 persons killed by electricity; he knew nothing of the conditions under which they were killed, and had heard of others who had come into contact with a dynamo who were not killed. He had himself taken a heavy charge from a dynamo, and had the flesh burnt from his hand. He did not believe, however, that any person "ever withstood the full pressure from an ordinary dynamo and survived." (This is how it is reported, though it really seems too puerile to be true. What is an "ordinary" dynamo?) The witness then swore that in his judgment the instruments furnished would kill speedily and painlessly. He stated that the average resistance of the human body was 2,500 ohms, and that he would fix upon 4,000 ohms as the maximum. The highest he had found in animals was 30,000 ohms. The real object of his pamphlet was to show that high-tension alternating currents were dangerous, and that high-tension continuous currents could be made safe. Mr. Brown said that Ohm's law was universally recognised as absolutely correct, and the resistance and E.M.F. being known, the current could be determined. This he had only ascertained approximately for living animals, as the resistance varied. No burning of the flesh would take place with a properly moistened electrode. Beyond all doubt in his mind a pressure of 1,000 to 2,000 volts alternating current led into the body from head to foot, would prove fatal. "Take a man having a resistance of 50,000 ohms," asked the counsel, "would that vary your opinion?" "It would not." "With 1,000 to 2,000 volts?" "If it were properly applied." "In what time would death ensue?" "Within 15 seconds." Lawyer Cockran then elicited from the witness that he had studied static electricity at school, and also his positive opinion that Ohm's law applied to the alternating as well as to the continuous current. Mr. Franklin L. Pope, past president and member of the executive council of the American Institute of Electrical Engineers, then stated that he did not think the resistance of the body could be accurately determined. He had tried himself that morning and found it varied from 6,300 ohms with a 1-volt current down to 3,500 ohms with 100 volts. He was familiar with the Westinghouse dynamo of 1,050 volts, and did not think it could generate the force claimed for it by Mr. Brown. He thought the flesh would always be burnt with a current sufficient to cause death. He had reason for believing that the death by electricity was an exceedingly painful one; and that so far as the practical bearing of the experiments on animals went, he regarded them of little value. Other testimony is to be heard,

THE EDISON THREE-WIRE SYSTEM OF DISTRIBUTION.*

BY W. J. JENKS.

In the use of electricity for the production of light the world has realised one of the most far-reaching and commercially important of the myriad applications of this marvellous manifestation of energy. We may well pause for a moment at the outset and repeat this term, manifestation of energy, while we fix firmly in mind the fact that in calling forth the light of the vapourising carbons of the electric arc or the glowing filament of the incandescent lamp we are but changing the old time energy of the sun's light and heat, long dormant in the coal we burn, back to the energy of chemical action, heat, expansive power of confined vapour, motion, magneto-electricity, heat and light once more. In order that we may more clearly grasp the salient points of comparison between the purely electrical diagrams and the water analogues to which we shall refer, it will not be out of place to rapidly review the ideas suggested by the electrical units most often involved in any effort at comparison.

ELECTRICAL AND HYDRAULIC UNITS.

1. Potential: Energy represented by a difference in the electrical condition of two bodies or points in space, as in hydraulics the difference in level of two bodies of water represents the expenditure of force necessary to place them in this attitude of contrast.

2. Electromotive Force: The active pressure resulting from the difference of potential, and corresponding closely with what we may call the mechanico motive force resulting from a difference in level of two bodies of water. The pressure of water is measured in pounds; that of electricity in volts.

Thus in both water and electricity we have difference of potential while no work is done. The pressure exists, and it is possible by an absolute electrometer to measure static attraction (the result of pressure where no work is done or no flow occurs) down to a few volts. Sir Wm. Thomson has recently attempted to reduce this principle to a practical form by putting upon the market an electrometer corresponding to a water or steam gauge, reading from about 400 to several thousand volts. Practically, however, we measure electrical pressure only when we make an outlet for it, and from the flow through a known resistance we calculate the fall of potential. The current being the same at all points in a perfectly insulated circuit, it is evident that the potential only is lost, or, in other words, the energy which has produced the difference of pressure, and been temporarily or momentarily stored up, as it were, has been expended, and the arrested motion or velocity transformed into heat. Here, then, is one cardinal idea—namely, electricity is not in itself a source of energy, but a means of transference or transmission.

3. Resistance to electrical action: Represented by ohms, while for the friction of water in pipes we have no unit of measurement.

4. Intensity or force of flow resulting from E.M.F. modified by resistance: Represented by amperes. For this action hydraulics has no unit.

5. Quantity of force delivered in a given time, or amperes per second: Expressed in coulombs; measuring a dynamic discharge as we measure gallons per second in hydraulics.

6. Power conveyed through a conductor by the flowing of any current at any pressure, or the rate at which energy is expended or work done: This is the product of the E.M.F. and the resulting current, and is measured in watts.

7. Work done or heat generated by a current during a certain period, or by a certain number of coulombs at a specified pressure: This is expressed in joules.

It is often convenient to compare electrical with mechanical energy by remembering that 746 watts is the equivalent in electrical units of one mechanical horse-power, 550 foot pounds per second.

COMPARATIVE EFFICIENCY OF ELECTRIC LAMPS.

It is quite evident that we can only secure a lower percentage of the efficiency in a light produced by expending

our power in bringing a carbon to incandescence, but still retaining its form, and for a certain time perpetuating its existence, than we can where we raise this carbon to such a heat as to speedily dissipate it. It follows, therefore, that the incandescent lamp, even considering the greater life of the carbon in the vacuum, is less efficient as a means of converting the energy of electricity to that of light than the arc lamp; and Prof. Nichols has shown in a very able paper within the past few months that with the old type of Edison lamp the efficiency was about one-half of that of a standard nominal 2,000-c.p. arc. The adoption of the new type has so far increased the efficiency of the Edison lamp that we now stand to the arc lamp a $7\frac{1}{2}$ to 10, or about 75 per cent.

It was the knowledge of this lesser light-producing power of an incandescent filament, coupled with the difficulty of producing currents of an E.M.F. low enough to be practically safe for domestic uses by machines of sufficient capacity to serve as factors in a centre of supply for the light of a town or city, and the great loss attending the distribution of such currents, which made the European scientists so positive, less than nine years ago, that no commercial results would follow Mr. Edison's incandescent experiments, and sceptical as to the success he finally achieved even in comparatively small isolated plants, up to the time of his demonstration at the Paris Exhibition, and afterward regarding central station lighting, until, on September 4, 1882, the engines of the New York system were set in motion, and electricity was, for the first time, commercially sold as light by electrical measuring devices.

The greatest triumph of the Edison plan is realised in its adaptation to this central station distribution, which is properly the subject of this paper. With this method at our command we deliver current at any point within a given district for any number of lamps within the capacity of its conductors, precisely as a gas or water system supplies its energy, and in so doing enter by far the largest field for illumination of any kind, interior spaces, and particularly stores and dwellings, where, by reason of its superior softness, steadiness, and economy, the incandescent lamp must ever hold the ground as against all other methods.

THE HIGH-RESISTANCE LAMP.

In analysing the secrets of the success which has attended the work of the New York station, the initial experimental ground where to-day may be seen the demonstration on a grand scale of the hypothesis of less than seven years ago, we find undoubted advantages secured by the use of the principle of multiple arc distribution; we find, also, a wonderfully low resistance in dynamos, and in the bars of copper constituting the main conductors, but we also find that without which these other favourable conditions would be of little avail, a high-resistance lamp.

Suppose we have a water-motor so constructed that it delivers one h.p. of energy when using 10 gallons of water per minute. Suppose this quantity of water to be secured through a pipe of 1 in. diameter, at a distance of 100 ft. from the source of supply, by a pressure of 50 lb. at the reservoir or pump. If, now, we can so modify the motor that only five gallons of water per minute is necessary to do the same work, we shall find that to secure the passage of the five gallons through its mechanism the pressure must be raised to 100 lb., and that as long as it is safe and economical to make use of this increased pressure we can carry the motor much farther away, and secure the same result at an additional cost for pipes less than the advantage gained in distribution.

So in incandescent lighting. Mr. Edison diminished the amount of current necessary to furnish a given light by raising the resistance of the carbons far beyond the point reached by other inventors. With less current to carry, less copper is required for a specified distance; and as, in addition, greater pressure is required at the dynamo, the same size of wire will carry current for a specified number of lamps at a greater distance.

HIGHER PRESSURE—INCREASED ECONOMY.

But even this advantage did not suffice. The first New York installation showed too serious a first cost in con-

*From the *Electrical World* (New York).

ductors to serve as a type for general work of this kind, and when this became apparent to Mr. Edison the problem of introducing a higher pressure into the main channels of distribution was attacked with vigour, and a satisfactory solution secured in what is known as the three-wire system, which has shown itself the lever which has lifted the business over the dead centre between failure and success. Here we couple two dynamos in series, thereby utilising their combined E.M.F. and doubling the available current delivered over a given pair of wires at any point on the main conductors, while the attachment of a third wire to the link connecting the two makes it possible to use in any one lamp the force of only one generator and to make each lamp separately controllable. This peculiar arrangement and its contrast with the old two-wire principle is made plain by the illustration, Fig. 1. Here we recognise the familiar idea of two parallel conductors connected with the dynamo, A, and at *a* and *b* lamps in multiple are on the main wires and in any illuminated space, *c*.

Here we conceive of the outgoing current as traversing the positive main and all its conducting branches to the lamps, and returning, after doing its work, to the negative terminal of the dynamo. In such a system, of course, the greatest difference of potential to be considered is that existing at the brushes, which in central station work usually amounts to an E.M.F. of from 115 to 130 volts, according to the loss anticipated by the calculated resistance of the conductors and the resistance of the lamps to be used.

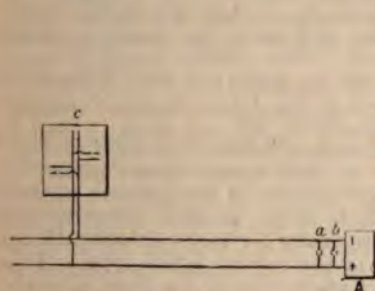


FIG. 1.

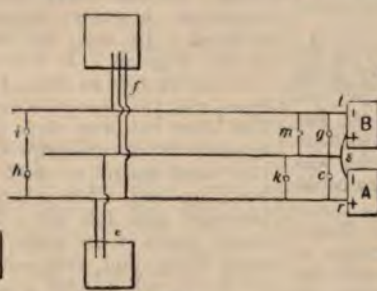


FIG. 2.

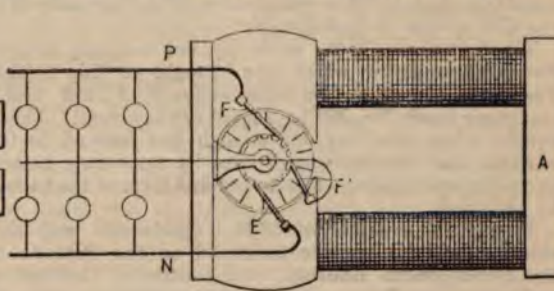


FIG. 3.

The Edison central stations, where the loss in distribution, when the system is taxed to its ultimate capacity, is from 10 to 15 per cent., are usually supplied with lamps requiring, in different cases, from 105 to 115 volts, and the economy of their use is thus made equal to that of isolated plants where the drop in potential from dynamo to lamp seldom exceeds 5 per cent., and where the lamps may be from 90 to 100 volts. It is now easy to illustrate the importance of a high-resistance lamp and a low-resistance armature.

Suppose the dynamo in Fig. 1 to be capable of feeding 1,000 16-c.p. lamps. Before connecting any lights we have, if our insulation be perfect, an infinite resistance between the conductors and (disregarding that of the field-magnets), say 0.01 ohm in the dynamo. Now connecting one lamp, 200 ohms, and throwing out the resistance of the conductors, we have $\frac{0.01}{200}$, or only $\frac{1}{20,000}$ the resistance of the whole circuit in the machine, leaving all but a minute fraction of the energy developed by the armature to be expended as useful work in the lamp. At this stage of the experiment the resistance of the lamp circuit is at its highest point.

Now turn on all of the 1,000 lights. Their joint resistance is 0.2 ohm, and so long as the coils of the armature remain cool the ratio will stand $\frac{0.01}{0.2}$, indicating that $\frac{1}{20}$ of the current is doing commercial work.

Having now arrived at the normal capacity of the generator, if the number of lamps be still further increased, a second dynamo must be connected in multiple with the first, so that the armatures may jointly give a sufficiently low internal resistance and the E.M.F. be kept up at the lamps. The method of doing this will be described further on.

Now transfer dynamo A to a new position, Fig. 2, and connect it in series with another of the same type, B. Belting both to the same engine, and running a third wire

from any point on the conductor, *s*, between the two, we have the positive terminal of the combined system at *r* and the negative at *t*, with the middle wire alike negative to A and positive to B.

If the machines be run at their normal speed the difference of potential between *r* and *t* will thus be, say, 200 volts, and between *r* and *s*, or *s* and *t*, 100 volts, or just the proper force for one lamp. If such a lamp, as at *c*, be connected, the A machine will be doing work, and the current will return through *s* to its negative terminal. If, instead, *g* be turned on, only B will produce current. In case both *c* and *g* burn at once, the effect will be exactly as if *h* and *i* (or *k* and *m*) were in use; the double E.M.F. then working through the double resistance to produce the same number of amperes as before, and the middle, or, as it is technically known, the "neutral" or "compensating" wire, practically cut. If the number of lamps on one side exceeds that on the other, a current will flow through the neutral to or from the machine carrying the heavier load, and by actuating the needle of an ampere indicator, will, by its direction, show the side most taxed, and, by the angle of its deflection, serve as a measure of the difference between the two.

Now, we are able to illuminate any buildings or spaces, *e* and *f*, by attaching their lamps to the A and B side of the circuit respectively; and supposing the distance of these points from the dynamos to be, for instance, one-half mile, we have sent the current over that interval at an E.M.F. double that employed in the two-wire plan. To secure the same loss with the same number of amperes,

therefore, we need a wire of but half the cross-section used before. But having doubled the pressure, we are actually using but one-half the current previously consumed to transmit the same total energy, and hence our two wires need weigh but one-quarter as much as those in the first installation. The addition of a third wire as an equaliser raises the outlay to three-eighths of the original.

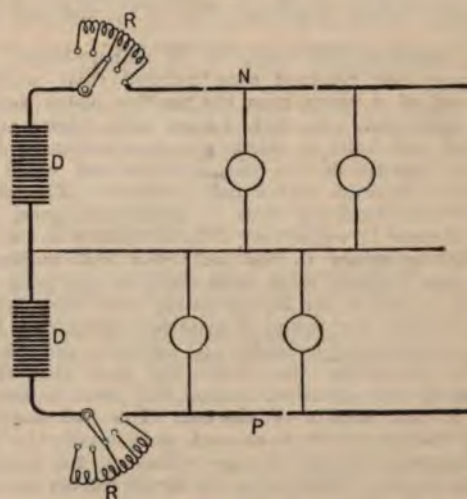


FIG. 3a.

To make this point more clear, notice that the joint resistance of *a* and *b* is, in the two-wire system, $\frac{200}{2} = 100$ ohms. With 100 volts pressure, they absorb $\frac{100}{100} = 1$ ampere. Place the same lamps at *c* and *g*, and their joint

resistance (in series) is 400 ohms. With 200 volts E.M.F., they, therefore, absorb $\frac{200}{400} = 0.5$ ampere, and this one-

half the original current, which at the old pressure could be carried by a wire of one-half the size, being sent from the dynamo to the lamps at twice that pressure, can be supplied through four times the resistance, are one-quarter the mass of copper. Consequently, one-quarter the weight of wires will supply the same number of watts of energy, and hence give the amount of light as before.

(To be continued.)

SOME RESULTS WITH SECONDARY BATTERIES IN TRAIN LIGHTING.*

BY ALEXANDER S. BROWN.

The arguments in favour of the incandescent electric light for railway passenger trains are so well understood by the members of the institute, from their own general knowledge of the subject, as well as from papers previously presented, that it is unnecessary for me to allude to its admitted superiority over either gas, oil, or candles. It is now four years since the Pennsylvania Railroad, appreciating the advantages of electric lighting for this purpose, began a series of experiments with the secondary battery, for the illumination of parlour cars.

I am unable to give the cost of lighting by any of the batteries referred to, as the expense appears to have been a secondary consideration compared with the necessity of securing the best system of illumination.

The first experiments made by the company were with the Faure accumulator which was brought to this country from France in the spring or early summer of 1882, and put on passenger coach No. 397 in August of that year. The car was run for a few days only, but enough was learned in that time to show that the lighting of cars by secondary batteries was perfectly practicable, when a modified form of the battery could be obtained.

During the summer of 1884, experiments with the Brush storage batteries were commenced at the Altoona shops of the Pennsylvania Railroad, and continued through the fall and winter of that year. These experiments were made by Dr. Dudley, and proved so successful that eight parlour cars, which were being constructed at that time, were equipped for incandescent lighting, and put into regular service on the 1st April, 1885.

The Brush cells used consisted of three plates each, two negative and one positive, the amount of surface of the positive plate being equal to that of both the negatives. These plates differed from those now used, there being no paste in their composition. The negative plate herewith shows the form of construction, and was designed to give the greatest possible amount of surface from the least weight of material. The positive plate measured $8" \times 9" \times 1"$, and the negative $8" \times 9" \times \frac{1}{2}"$.

These batteries were rated at 70 ampere-hours, but the hard usage they received soon reduced their capacity, and at the end of a year's time the positive plates were almost entirely destroyed. In fact, I have taken plates out of the cells which had holes in them fully four inches in diameter, while the deposit in the bottom of the cell would be from an inch to an inch and a half in depth. The plates also had a decided tendency both to buckle and grow, and in a number of cases it was a very difficult matter to remove the plates without injury to the cell; you will understand, of course, that I allude more particularly to the positive plate. The weak points in the Brush battery were the small number of ampere-hours per pound of material—about two, I believe. There was a tendency to buckle and sulphate, and the arrangement for connecting the plates was such that there was oxidation at the junction, causing the plates to break when subject to the motion of the car. This last feature was a source of endless trouble to us, and, as is usually the case, was sure to happen at a time or place where it was impossible to repair the break. While using the Brush battery the cars were wired with the battery-boxes, one on each side of the car, coupled together in series, each box holding three trays, and each tray containing four cells, this giving a total of 24 cells to a car, or a current of 48 volts. The lamps used originally were of the Brush-Swan type, with small platinum hoops projecting from the base, these hooking into a socket, and held in place by a spiral spring, this socket fitting into another one, to which the connections to the wires were made.

After using this style for some time, an improved pattern of Brush-Swan lamp was substituted, but the great

drawback to this lamp was its frailty, the breakage per day often averaging four per cent. of the total number of lamps in use on all the cars. These lamps required about 45 volts and one ampere of current, and each car contained 10 lamps, seven in the body, one in the smoking-room, and one in each vestibule, thus using about 10 amperes of current, and as the batteries were rated at 70 ampere-hours, we should have obtained from six and one-half to seven hours good light, but it was very seldom, after the batteries had been used for a short time, that we could get over five and one-half hours. As will readily be seen, this could hardly be called economical, for to obtain five or six hours' light we were obliged to charge from 15 to 20 hours with a Brush arc light dynamo giving a current of about 10 amperes. Then, taking the weight into consideration, each time the car needed charging, the trays, six in number, and weighing 1,200 lb., had to be loaded on the truck, pulled over to one side of the car, and there discharged trays taken out and the freshly charged ones put in their place. The remaining three were then taken around to the other side of the car and changed in the same manner. As the cars invariably stood on a double track, it was necessary to carry half the trays for some distance, over tracks, etc. Then, again, the tracks were usually full of cars, and if there was not sufficient time for them to be parted the batteries had either to be carried under the car or over the platform. Under the present system this has been done away with to a great extent, as will be explained subsequently. During the month of December, 1886, we commenced using one battery of the 7 B type, manufactured by the Electrical Accumulator Company. This battery was a decided improvement over those previously used, giving as it did nearly double the number of ampere-hours for the same weight of material. After using this battery for about a year the positive plates began to give way, and new ones were substituted, the negatives, however, being retained, they not having deteriorated. In fact, we are still using the negative plates of our original 7 B battery. This battery proved to be so satisfactory that in June, 1887, we added two more of the same type, and two manufactured by the Julien Electric Company. The latter batteries were similar in size and shape to the 7 B type of the Accumulator Company, but did not seem to stand the hard usage so well, as they would crack instead of buckling and allow a large quantity of the paste to become loosened and fall out. It is proper to state, however, that these plates were made especially for us, to fit the cells we were using, and were not of the regular Julien type. This no doubt will account in a great measure for their failure to keep up to the standard of the present type of Julien batteries. After the positive plates of this battery became worthless, and not having any others to put in their place, we decided to make a kind of consolidated affair and see how Julien negative and accumulator positive plates would work together. The result was extremely satisfactory, and we have had no trouble with them whatever, excepting the occasional buckling of a positive plate.

During the fall of 1887, we began substituting the accumulator batteries for the Brush batteries, and by the end of the year we were using them altogether, with the exception of the two Julien I have mentioned. We, however, kept 96 of our best Brush cells to be used in case of an accident to the incandescent dynamos, which are used to supply the current for the railroad telegraph as well as for lighting the passenger station.

After the change in batteries had been made, it was thought best to change the system of wiring the cars, so that instead of it being necessary to put batteries on each side of the car, we need only put them on one side and get the same amount of light. This was done by connecting the two boxes under the car in parallel, and substituting 23-volt Edison lamps for our 45-volt Brush-Swan lamps. After doing this we found that we were able to get as many hours' light, from 12 cells as we formerly did from 24. Of course this change reduced the expense of lighting the cars considerably, for where we formerly had a change of battery for each car, or 48 cells, we now needed only 24 cells per car, with a few extra ones to be used in case the 12 cells would not be able to supply sufficient light for a long trip. This system of lighting proved so successful, that it was decided to substitute it for gas in the remaining seven parlour cars. The wiring of these cars was commenced at the Meadow shops, near Jersey City, last September, and has just been completed. These cars are arranged for the 23 C type of the Accumulator Company's battery and 19 B type of the Julien battery. The battery boxes under the cars are larger than the old style, and contain four trays or 16 cells, the lamps we used taking 23 volts of current. Changes were also made the first of the year in the system of charging, and the batteries are now charged from an incandescent dynamo instead of an arc, thus enabling the batteries to be charged with any amount of current desired. In connection with this description of the four years' work of the Pennsylvania Railroad, I would like to add something in regard to the electric lighting of the Chicago limited express.

* Paper read before the American Institute of Electrical Engineers.

In 1887, the Pullman Palace Car Company commenced using the electric light on one of three trains of the New York and Chicago limited express, and the charging of the batteries at Jersey City was given into the hands of the Pennsylvania Railroad Company. The batteries used were the 7 B type of the Electrical Accumulator Company, 30 cells to a car, and usually there were six cars in the train. These batteries would furnish enough light for one trip, and each time the train arrived at either terminus it was necessary to replace them with freshly charged cells. This was not objectionable at Chicago, for the train arrived there in the morning, so that they could be charged during the day, but in Jersey City, where the train did not arrive until evening, the work was very difficult on account of the dynamo being in use for other purposes. After this one train had been running a short time, another one was fitted up, 19 B type of Julien battery being used. It was thought that this would give us a chance to see which was the better of the two batteries, but they both worked very well considering the treatment they received. After Mr. Bauer became connected with the Pullman Company, he did away with charging the batteries at the ends of the line, and introduced a Brotherhood engine and Eickemayer dynamo in the baggage car of each train, in order that the batteries might be charged in transit. When the train leaves Jersey City the baggage car is on the rear, and consequently no charging is done until it leaves Philadelphia, where the train is reversed, bringing the baggage car next to the locomotive. The batteries are charged continuously until the train reaches Chicago, and the same practice is continued on the return trip. The steam for driving the Brotherhood engine is taken from the locomotive boiler, and the exhaust is used for heating the train.

So far as the Pennsylvania Railroad is concerned, the electric lighting of passenger trains may be considered an assured success; and leading as it does to the abolition of kerosene lamps, and incidentally encouraging the adoption of steam heating, the safety and comfort of the passenger is certainly increased.

DISCUSSION.

Mr. Geo. B. Prescott, Jun., Egypt: I am sure the Pennsylvania Railroad Company deserve a great deal of credit for making the experiments described in Mr. Brown's interesting paper. They have demonstrated one thing very positively, and that is, that an accumulator made entirely on the Planté principle, without active material, applied according to the Faure method, is an impracticable battery for commercial purposes. The improvement in storage batteries of late years, particularly in the past year, has been very great, and the experience which the practical use of batteries has given us goes to show that unless they are handled as if they were a delicate piece of machinery, they will never give very satisfactory results. Wherever accumulators have been properly installed and treated as if they were worthy of being properly cared for, they have been reliable and have fulfilled certain conditions that no other electrical machinery does fulfil to-day. The improvements in the service of accumulators are not confined to the cells themselves. No matter how good an accumulator may be, if it is not properly installed with suitable apparatus for regulating both the charge and discharge, it will never work satisfactorily. If the accumulator is overcharged, the paste is peroxidised to such a high degree that it becomes a very fine powder and has not sufficient consistency to hold together, and it simply floats in the form of a powder and gradually deposits in the bottom of the jar. That comes from overcharging, and yet it was only a year ago that overcharging was thought to improve accumulators. We know now, also, that if the cells are allowed to overdischarge they become very heavily sulphated, and the longer they stand in a discharged state the more dense this sulphate becomes; and then if the charging is commenced at what would otherwise be the normal rate, the gas seems to be developed within the interstices of the pellets, and as the sulphate is not in a condition to take up the oxygen, it is liberated, and the result is that these pellets are forced out of the perforations, in chunks, so to speak. If, however, the cells are charged and discharged within certain limits, which can be determined for every size of cell, and if any short circuits that may occur through accident or other cause are removed at once, the accumulator to-day is a perfectly reliable piece of apparatus.

Mr. C. O. Mailloux: I would like to ask Mr. Brown whether the charging of accumulators at either of the termini of the road has been definitely abandoned in favour of the system of charging on the train.

Mr. Brown: In regard to the charging of batteries on a car or at the terminus, you will understand that the Pennsylvania Railroad still charge at Jersey City. It was the Pullman Company I alluded to. They have done away altogether with the charging at either terminus, with the exception of keeping a few spare cells both at Jersey City and Chicago, so that in case the train arrives in Jersey City in the evening, and anything is the matter with the cells or the trays, we simply have a good tray ready to put in its place.

Mr. W. H. Pierce: I would like to ask what was the weight of those cells per lamp, and if there have ever been any tests tending to show the quantity of steam used.

Mr. Brown: I really cannot say much about the Pullman work, because I am not connected with that in any way. I do not know just how much steam they require. The weight of a cell is about 50 lb. We use 12 cells, weighing 600 lb., to a car provided with 10 lamps—that is, 60 lb. per lamp.

Mr. Prescott: Any objection to making use of steam from the locomotive for driving the dynamo would seem to me not very well founded. We know that the use of steam for heating purposes, for heating cars, is being universally adopted, and steam could be used for driving a small engine to run the dynamo, the exhaust being used for heating the car. Moreover, the amount of steam required to drive the small engine is such an almost infinitesimal part of the total amount of steam generated in a locomotive boiler that it hardly need to be taken into account.

Prof. E. L. Nichols, Egypt: I should like to enquire of Mr. Brown whether he can tell us anything about the average life of accumulator cells used in railway service as compared with the life of the same type of cells doing the same amount of work when stationary. I have had this question asked me many times and have looked in vain for definite information concerning it.

Mr. Brown: I am sorry that I cannot answer; but I have had no experience with stationary cells. My experience has been confined entirely to railroad cells. We calculate our positive plates to last about a year. They are in use almost all the time; they have much more usage than stationary cells. I do not think the motion of the train does them any harm at all. We do not find that the batteries splash. There is some little motion, but being in the centre of the car—they are long cars, about 65 feet—the motion there is very little.

Mr. W. B. Vansize: I have heard it suggested that there might be some considerations advanced in favour of the oscillatory motion due to use on a railroad car, because of the agitation of the liquid making a more even dispersion; that is, the specific gravity would be more equal at all points of the cell, and, while there might be some detrimental results from the shaking to which the material is subjected, the difficulty in that direction would be, perhaps, more than made up by the equal dispersion of the electrolyte. I do not know that any tests have ever been made to determine this question. As to the relative duration of a cell whose life is spent upon a car as compared with that used in stationary work, I do not know that it has been determined; but the general opinion is, so far as my observation goes, that the railway cell has a somewhat abbreviated life. The varied attention which the two classes of cells receive would also determine that result to a certain extent. A cell in use on a railroad train would naturally receive a little more careful attention than a stationary cell, unless a system of inspection be in use in connection with the latter.

Mr. Mailloux: The storage battery is never put to a more crucial test than when upon a street car. The requirements of a source of supply of electricity for street-car traction are, as everybody knows, very severe. My own experience and observation lead me to believe that if a battery on a car were submitted to the same rates of charge and discharge, and to the same treatment, it would last longer than in stationary service. In street cars the work is always necessarily much more severe. There are times when the battery has to withstand a current rate of from 50 to 100 amperes, while in stationary work the same battery would never have a current rate exceeding perhaps 25 to 35 amperes; and yet, even under such trying conditions, I have known of batteries, the positive plates of which were still quite good after 15 months' use—almost daily use. For a long time the plates were used daily at least once, and sometimes charged twice a day, and yet after 15 months' use the active matter was not gone and the plates were still good enough to do good work; and this would show that there must be something in the vibration or the shaking of the cells which counterbalances somewhat the hard usage which it receives in the way of excessive rates of either charge or discharge. The particular battery which I refer to was once discharged on short circuit while on the road by the bursting of an armature. While a car was going down a steep grade at a speed of, say, 20 miles or more, one of the armature bands ruptured. At the bottom of the grade the driver turned the switch to put on the current. The car did not move very fast, and something began to smoke. The trap-door was removed, and one of the motors seemed to be burned up. Upon investigation I found that the current rate of discharge had been sufficient to burn up one of the connecting strips by which the circuit was closed from cell to cell. In other words, one of these strips had acted as a fusible plug, and from its area of section I concluded that the current rate must have exceeded 300 or 400 amperes. I also found that the field-wire, which was No. 4½ Brown and Sharpe, had become heated sufficiently to char the insulation, to carbonise it almost entirely for the whole length. I naturally concluded that the batteries would be ruined. They were taken out and cleaned, and to my surprise I found that while there was some active matter in the bottom of the cells, it was not at all, in quantity, what I expected. In fact, it was so little that I did not know how much of it was due to that immediate circumstance, and how much was due to regular use. At any rate, the batteries were put in service again, except two of them, which were ruined by the melted lead flowing out where the circuit was broken by the destroyed connecting strip. Shortly afterwards, the same battery was again short-circuited by some accident in the station. It was short-circuited in such a way that only the field-wire of one of the motors was put across the terminals, and we did not know of it until we heard a violent hissing, and observed that the solution was boiling in several of the cells; the circuit was quickly opened. Again I thought the cells might be ruined, but after washing and cleaning they did a good deal of work after that. This goes to show that, in the first place, storage batteries will stand a much higher rate of current than they are generally supposed to with comparative impunity, and it corroborates perhaps the belief which I have, that when once the active matter of a storage battery has become thoroughly receptive by a proper course of treatment, either originally in the making of the battery or subsequently in the treatment of it, that you can do with it a great deal that would ordinarily be considered as abuse of a battery.—*Electrical Engineer* (New York).

THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence ; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices :

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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THE EXTENSION OF ELECTRICAL APPARATUS.

In our last issue was a casual remark to the effect that it was almost impossible to say what electricity could and what it could not do. Also that the extension of electrical apparatus in a variety of ways was merely a question of time and money. Great wonder is displayed every now and again by the uninitiated at some whimsical use made of the current. If a man rigs up a piece of apparatus to brush his horse or to clean his boots, that of course is put forward as something very wonderful, and indicative of the vast and rapid progress of electricity. The unknown, in fact, is always wonderful, and though we may doubt the accuracy of the tale which records the old mother as sending her son a new pair of boots by hanging them on the telegraph wire and getting back at sundown by the same means his old pair, we are by no means surprised that such tales should meet with pretty general credence. There is one direction in which necessity will ultimately compel a vast extension of electrical appliances. We refer to the safety of goods and chattels. The old Adam is still pretty rampant in modern society, and civilisation fails to teach to everyone the distinction between mine and thine. Bolts and bars are required everywhere, and great skill and ingenuity is shown in designing means whereby interiors shall be safe from visitors "who are not wanted therein." It seems to us that in this direction, again, America is setting us an example worthy to be followed. It is possible—indeed, it is comparatively a simple and inexpensive matter—to protect a room in such a manner that no one, be he the rightful owner or not, can enter or leave without indicating to other parties the fact. Of course, every door and window might be protected, and not prevent anyone getting through the walls, through the roof, or burrowing under the foundations and floor. Still, if unwelcome guests were driven to such means to get into an office, with the knowledge that at the end the plunder obtained might be of trivial value, there would be less housebreaking and fewer burglaries than at present. It may be said that the knowledge of those whom it was desired to circumvent would soon be equal to the occasion, and if safety was obtained by means of an electric current they would learn to cut or shunt the wire. But such an operation would be made to give an alarm, and, indeed, it is difficult to see how the best electrician could penetrate past a door or window properly certified as safe. Extension of the use of electrical apparatus will, in many instances, follow the lead of luxury. We should not be surprised to see a house fitted up to employ electricity in many ways not yet contemplated—to open and shut doors and windows, to brush hats, coats, and boots. It might be used, with much greater safety than gas, to obtain a warm bath, to get an early cup of tea or coffee; in ventilation, to

obtain incoming pure air at the temperature of the room and so avoid draughts. It is, again, almost lost labour to point out to telephone companies that their systems should commence with the idea that every house should have a telephone. The value of telephonic systems, with subscribers here and there, is not comparable with their value when generally used. It seems natural that a telephonic system should provide for two classes of users—the one comprising messages restricted to the district, the other for messages outside the district. The one comprises the multitudinous messages that would pass in a residential district between housewife and butcher, and baker, and other shopkeeper; or if in a business district, messages or business matters between business houses. As we say, the locality of most of these messages is restricted within a limited area. The other messages, comparatively few in number, pass from one district, or even town, to another. It would be interesting to know if any company has ever gone into this question fully—to get the cost of the wiring and the rental that might be obtained. The general impression is that the rental would be excessively moderate, not more, if as much, as double what is paid to the postal authorities. Undoubtedly the great question with the latter is what will pay best, and if the telephone was generally used it would seem that the present royalty might be with advantage considerably diminished. No mention has yet been made of what might be termed domestic traction. Here, again, is a vast future for electricity. There is no reason, when the current can be had just as gas can now be had, why three parts of our vehicles cannot with pleasure and with profit be driven by electricity. The initial cost of an electric carriage will be no more than the initial cost of carriages and horses, in many instances not so great. The cost of depreciation and maintenance of the electrical carriage should be less than that of the other. Constructed now for the luxurious and the wealthy, they should be sooner or later constructed for everybody. It is useless unless our business men look ahead; they must not hesitate to plunge into new fields that show signs of promise, and we are disposed to think that domestic electric traction will ultimately become a very large business. Of course it is taken for granted, and as beyond question, that in the near future every house of any pretensions will be provided with terminals by means of which accumulators can be charged. Our surmise depends upon the future success of accumulators, that this useful piece of apparatus will be certain in action, fairly lasting, not outrageously heavy, and not too costly. At the present time great differences of opinion are held with regard to accumulators, but this arises because one set of people require one design of accumulators to do everything, while the other maintain that accumulators, like dynamos,

must be designed for the work they have to do. Ubiquitousness is not altogether desirable in an accumulator. These, then, are a few brief remarks as to directions in which great progress is to be made, the most important, and probably that which will pay best, being domestic electric traction.

THE "DROP" AND SIZE OF WIRE IN WIRING CALCULATIONS.

BY G. T. EVANS.

The articles, with their accompanying formulæ, on house wiring, lately appearing in the *Electrical World*, while, no doubt, supplying the necessary practical information for those who may be confronted with wiring problems, and satisfying the majority of operators who are content with the simple way of doing a piece of work, do not, I believe, meet the demands of those whose besetting question is "Why," and who are for ever looking for a "Because."

As the "drop" appears to be the main stumbling block for a great many beginners, some having a vague impression that it is a resistance, it may be well at the outset, trite though it may seem, to define what the drop really is.

The drop in volts along a conductor connecting two points is equal to the difference of potential of these points, whatever the resistance of the conductor may be. Hence, if a circuit is composed of wire and lamps, the total drop in volts along the wire and lamps will be equal to the total voltage employed on the circuit; and the drop will be divided between the wire and the lamps in direct proportion to their relative resistances, or, in other words, will be inversely proportional to their conductivities.

For example, let us suppose a circuit carrying a total pressure of 50 volts, composed of a length of wire having a resistance of 50 ohms and a lamp having the same resistance. The drop being proportioned to the resistances, it is evident that in this case it will be equally divided, 25 volts being expended on the wire and 25 volts on the lamp.

In practice the voltage to be used at the lamp, the resistance of the lamp and the voltage (*i.e.* drop) to be used on the wire are generally known, and the first step is to find the resistance necessary to give the wire to cause the required drop. To illustrate: We have a lamp, resistance 50 ohms, voltage 48, to place in a position 20ft. from the street mains, the drop in volts on the wire to be 2. The pressure on the mains is 50 volts.

It is evident that the resistance of the wire is determined by the following proportion:

$$D_l : D_w :: R_l : R_w ;$$

Where D_l is the voltage on the lamp;
 D_w the drop in voltage on the wire;
 R_l the resistance of the lamp; and
 R_w the resistance of the wire.

Substituting the figures given in the example in the above proportion, we get:

$$48 : 2 :: 50 : R_w.$$

Therefore $R_w = 2.083$ ohms, which is the resistance of the required wire.

The resistance of the wire being known, we have now to find what size of wire, having the required length, will have this resistance. From a wire table we find that a foot of commercial copper wire 10.3 circular mils. (approximate) in area has a resistance of 1 ohm. Multiplying this number by the number of feet in the circuit—in this case 40—we learn that a wire 412 circular mils. in area and 40ft. long, has the same resistance—viz., 1 ohm. And since the resistance of the required wire is 2.083 ohms, its area in circular mils. must be the area in circular mils. of the 1 ohm resistance wire divided by 2.083, which is equal to 197.76 circular mils. This corresponds very nearly to a wire No. 27 B. and S. gauge. Of course such a fine wire would not be used in practice, for obvious reasons, but the principle remains the same.

Finally, problems of this class may be reduced to the

$$\text{formula: } \frac{10.3 \times l \times n \times v}{R \times D} = \text{circ. mils.}$$

Here, $10 \cdot 3$ = area in c.m. of 1ft. of copper wire having a resistance of one ohm; l = total length of wire; n = number of lamps; v = voltage of lamp; R = average resistance of lamp; and D = drop in volts on wire.

It is, of course, understood that this article applies directly to the two-wire system only; but formulæ and constants for other systems can easily be deduced from what has been said.—*Electrical World*.

PARIS EXHIBITION.—II.

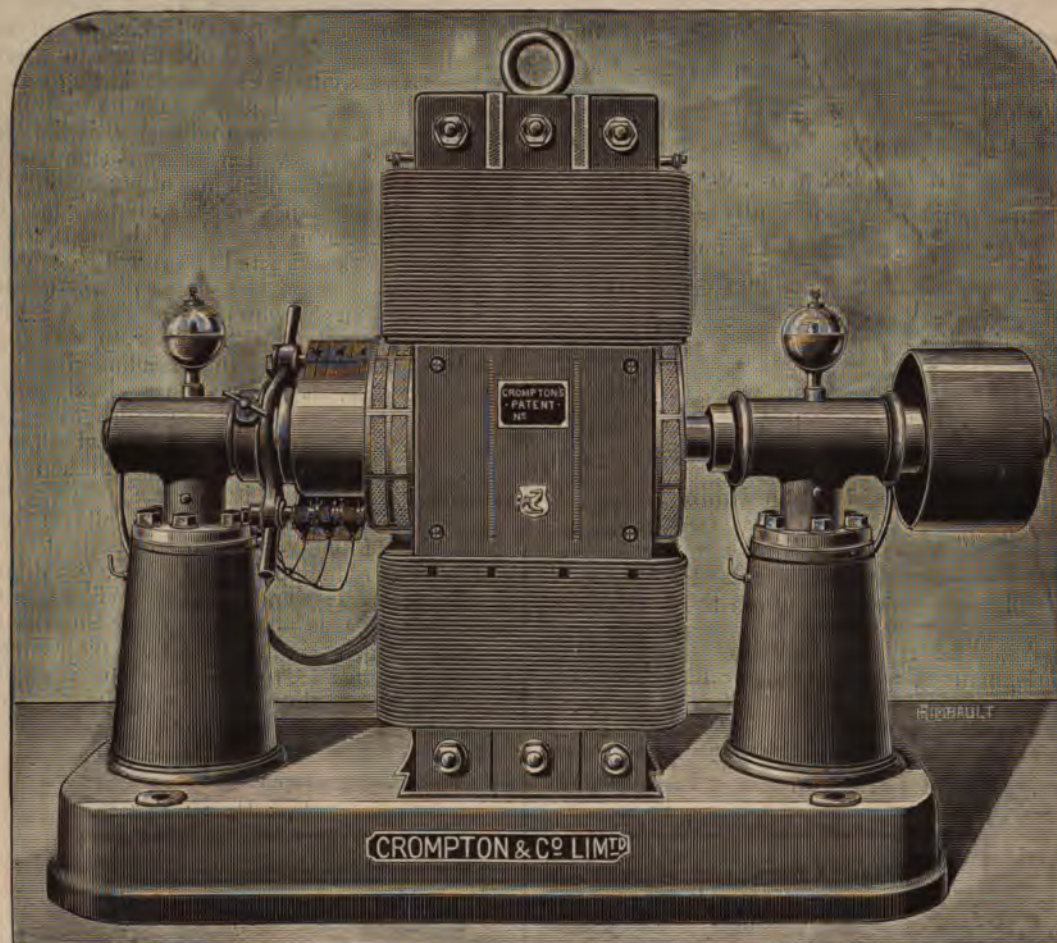
THE ENGLISH EXHIBITS.

The exhibits representing England in the Electrical Section of the Paris Exhibition do not give a correct idea to foreign visitors of the extent and variety of our progress in the science and practice of electrical engineering, especially when compared to the elaborate displays of some of the

EXPOSITION DE PARIS.

PRODUITS ANGLAIS.

Les produits représentant l'Angleterre dans la section électrique de l'Exposition de Paris, ne donnent pas une idée correcte aux visiteurs étrangers, de l'étendue et de la variété de nos progrès dans la science et dans la pratique de l'art du mécanicien électrique, spécialement lorsqu'on les compare avec les grands étalages de quelques-uns des mécaniciens belges et français; et la raison en est que malheureusement, à part d'une ou deux exceptions, les plus grandes maisons et aussi les plus grandes compagnies, qui s'occupent de mécanique et de lumière électrique n'exposent pas. Ceci est probablement dû jusqu'à un certain point, à la nécessité d'embarquement pour traverser la Manche, et on est privé de l'inspection de beaucoup de systèmes anglais concernant la lumière électrique, aussi bien que de l'ap-



The Crompton Low-Tension Dynamo.

French and Belgian engineers, for the reason that unfortunately, with one or two notable exceptions, the largest electric lighting and engineering firms and companies of England are not exhibiting at all. This is probably to some extent due to the necessity for shipment across the Channel, and we certainly miss the sight of many English systems of lighting as well as the application of motors to mining—which is becoming so successful in England; to tramways, both by accumulators and by underground conduits; and the overhead "telpher" system of electric traction for goods and passengers; and also the application of electric motors to cranes, saws, lathes, and to engineering generally. But it must not be forgotten that the reason some of the large English companies do not show exhibits or only small ones is due to the fact that many of them—such as the Edison and Swan Company, the Electrical Power Storage Company, Woodhouse and Rawson, and others—have separate concessions in France, with a distinct manufacturing company, with whom it is not politic to enter into competition. The English exhibits that are shown,

application dans les mines des moteurs—qui s'emploient avec tant de succès en Angleterre,—pour les tramways, au moyen d'accumulateurs et de conduits sous terre; et le système suspendu "telpher," de traction électrique, pour marchandise et pour voyageurs; aussi l'application de moteurs électriques pour grues, scies, tours, et la mécanique généralement. Mais il ne faut pas oublier que la raison pour laquelle quelques unes de grandes compagnies anglaises n'exposent pas, même sur une petite échelle, est due au fait que quelques maisons, telles que l'Edison et Swan Cie., l'Electrical Power Storage Cie., Woodhouse et Rawson, et quelques autres ont des concessions particulières en France, avec une compagnie manufacturière distincte, à laquelle il ne serait pas politique de faire concurrence. Les produits anglais que l'on expose, se rapportant à la lumière électrique et à la distribution, aux signaux électriques, et autres applications, sont cependant très intéressants, et incorporent plusieurs systèmes, nouveaux sur le continent, qui se recommandent aux mécaniciens qui visitent la section anglaise.

however—of electric lighting and distribution, of electric signalling, and other applications—are very interesting and embody several systems, novel to the continent, which must commend themselves to engineering visitors to the English section.

It may be well to mention that the engineer of the British section may be consulted in the office at the very end of the Palais des Machines, behind the bicycle stands; and that Mr. R. Aylmer, who represents the greater number of British exhibitors at the Exhibition, has an office in the third avenue, just below Messrs. Crompton's stand, where business information respecting the various exhibits may be obtained.

MESSRS. CROMPTON AND CO., LIMITED.

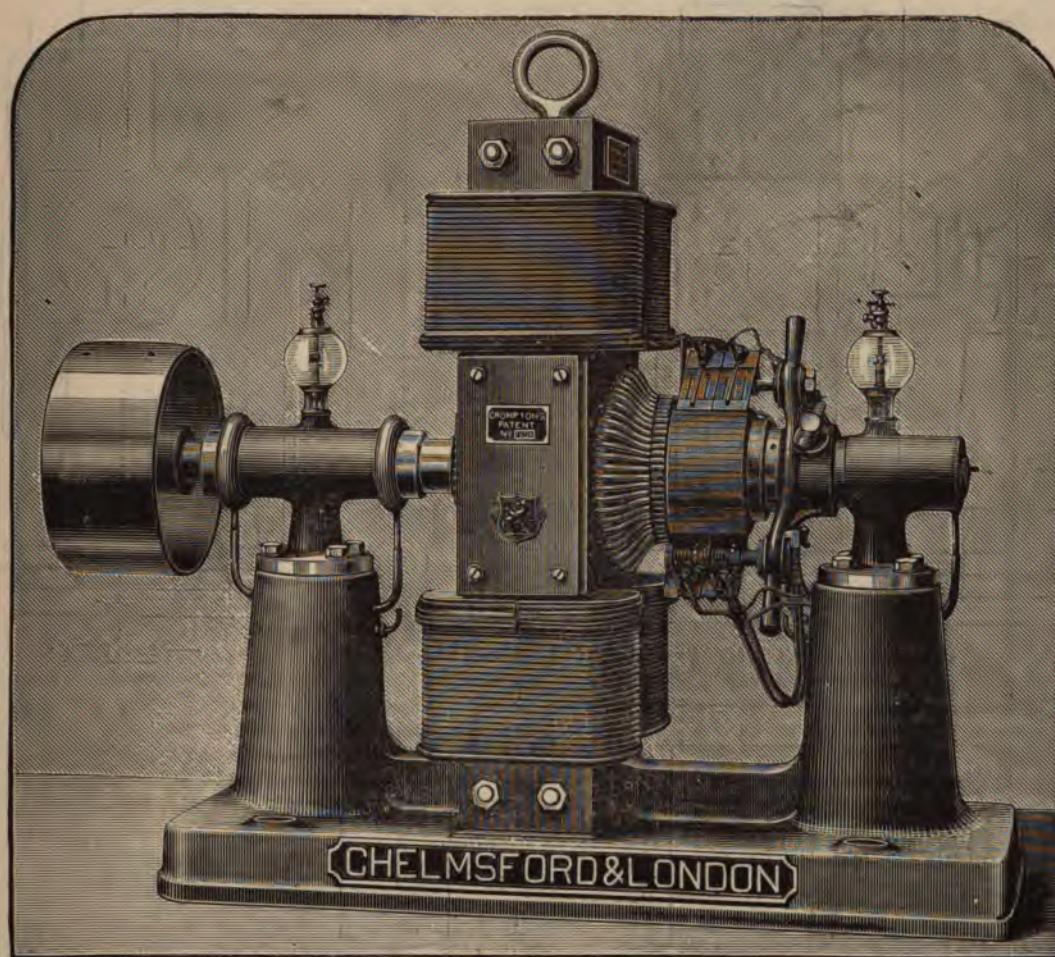
The first in importance among the electric light exhibits in this section is that of Messrs. Crompton and Co., Limited, of Mansion House-buildings, Queen Victoria-street, London, E.C., whose works are situated at Chelms-

Il est aussi bon de faire remarquer que l'on peut consulter le mécanicien de la section britannique au bureau, à l'extrémité du Palais des Machines, derrière les étalages de bicycles, et que M. R. Aylmer, qui représente le plus grand nombre d'exposants anglais à l'exposition, a un bureau dans la troisième avenue, exactement au-dessous de l'étalage des MM. Crompton, où l'on peut obtenir tous les renseignements commerciaux concernant les différents produits.

MM. CROMPTON ET CIE., LIMITÉE.

Parmi les objets se rapportant à la lumière électrique, les plus importants dans cette section sont ceux de Crompton et Cie., limitée, de Mansion House-buildings, Queen Victoria-street, Londres, E.C., dont les usines sont situées à Chelmsford, Angleterre, et les bureaux, à Paris, No. 40, Avenue de Suffren, sous la direction de M. J. A. Berly.

La vitrine de Crompton et Cie. se trouve dans la troisième avenue du Palais des Machines, presque au bout,



The Crompton High-Tension Dynamo.

ford, England, and whose branch office at Paris is at 40, Avenue de Suffren, under the management of Mr. J. A. Berly.

Messrs. Crompton's stand is in the third avenue of the Palais des Machines, near the top, and consists of a complete installation of electric light for arc and incandescent circuits, with engines, dynamos, switchboards, and all apparatus complete, as used for public or private installations. From this stand Messrs. Crompton are lighting, by means of arc lamps suspended from the roof, the whole of the English and American sections, and part of the French and Belgian sections, comprising nearly one-third of the whole of the Palais des Machines and the adjacent galleries and vestibules. Steam is supplied by the Syndicate of Electricity from four boilers of the inexplosible tubular type, one large and three small, situated in the building of the syndicate outside the Palais des Machines. These boilers are connected together, but can be disconnected separately by means of a stop valve: together they supply 4,200 kilos. of steam per hour, at 150lb. pressure or 10 atmospheres, and

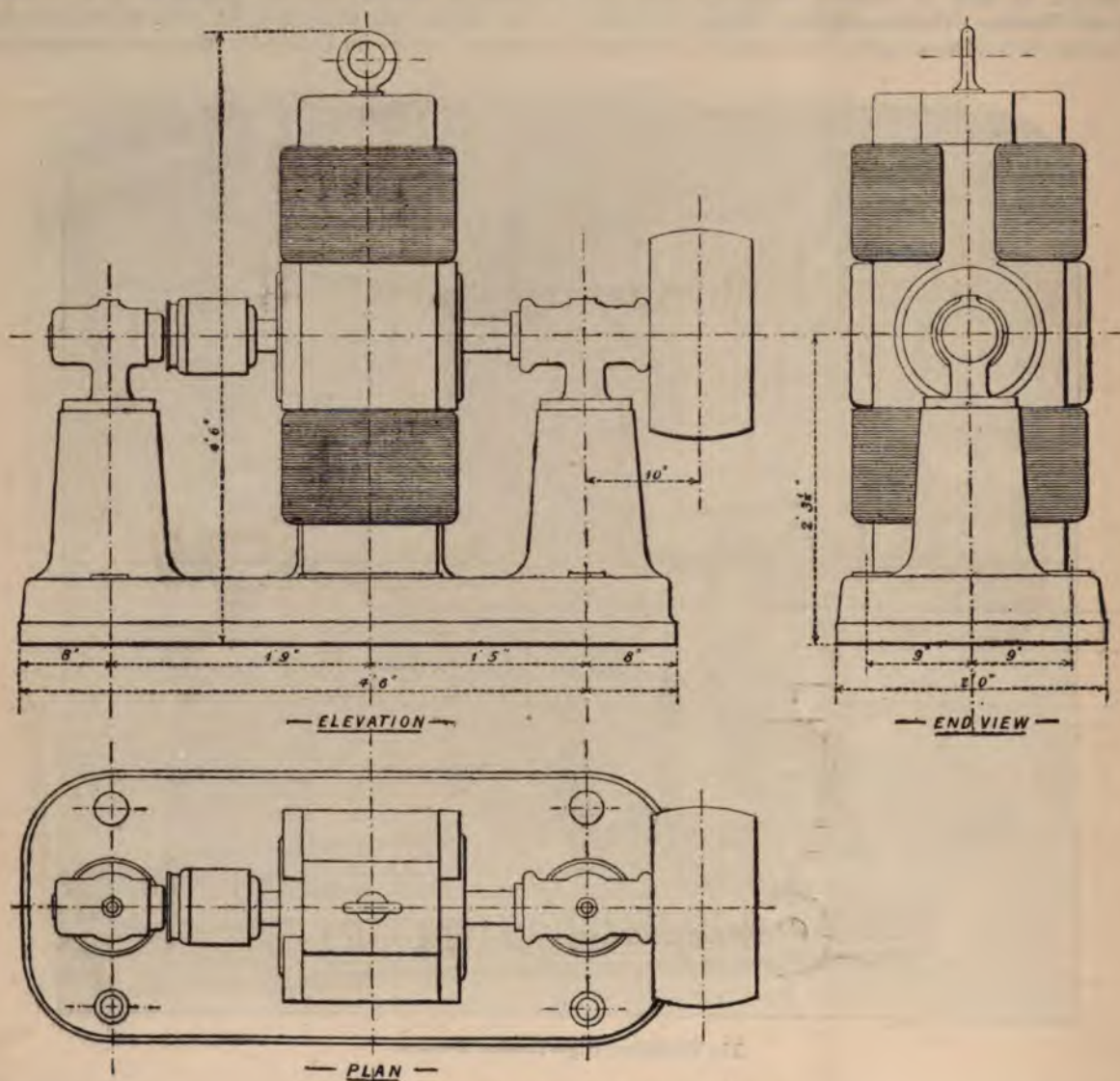
et consiste d'une installation complète de lumière électrique pour les circuits incandescents et à arc, avec machines à vapeur, dynamos, commutateurs, et tous les appareils complets dont on se sert pour les installations publiques ou particulières. A partir de cette vitrine, Crompton et Cie., éclairent au moyen de lampes à arc suspendues du toit, toutes les sections anglaises et américaines, et une partie des sections belges et françaises, ce qui comprend presque un tiers de tout le Palais des Machines et les galeries et vestibules adjacents. La vapeur est fournie par le Syndicat d'Electricité au moyen de quatre chaudières du type tubulaire inexplosible, dont une grande, et trois petites, sont placées dans le bâtiment du syndicat en dehors du Palais des Machines. Ces chaudières sont jointes ensemble, mais peuvent être détachées séparément au moyen d'une soupape. Ensemble ils fournissent 4,200 kilos de vapeur à l'heure, à 10 kilogs. de pression (150 livres per pouce carré), et la plus grande des quatre (fournissent 2,000 kilos) est suffisante pour faire marcher tout le matériel en cas de nécessité. On transporte la vapeur à une distance d'environ 200 mètres

the largest of the set (supplying 2,000 kilos.) is sufficient to work the plant if necessary. The steam is conveyed a distance of about 600 feet in steam-pipes of 6in. diameter, mostly underground; the pipes are fitted with expansion joints, steam separator and trap.

Three single-acting, high-speed Westinghouse engines are used, of 100 h.p. actual each, working at 150lb. per square inch pressure of steam, and running at 300 revolutions per minute. These engines are disposed in the form of a triangle on the stand, as shown on the plan. It was at first intended to use Willans and Robinson's direct driving engines, in combination with the Crompton dynamos on the same shaft, as used by Messrs. Crompton in many parts of England and elsewhere, but owing to the fire at the makers these could not be obtained in time. The use of direct driving engines would have made the installation

par des tuyaux à vapeur de 15 centimètres diamètre, pour la plupart sous terre. Les tuyaux sont ajustés avec des joints de dilatation, et séparateur de vapeur en trappe.

On se sert de trois machines de Westinghouse, à grande vitesse, à action simple, de 100 chevaux de force chacune, marchant à une pression de vapeur de 150 livres par pouce carré et faisant 300 révolutions à la minute. Ces machines sont disposées en forme de triangle sur la monture, comme sur le plan. On avait d'abord l'intention de se servir des machines à vapeur à actions directe de Willans et Robinson, combinées avec les dynamos de Crompton sur le même arbre, dont se servent Crompton et Cie. dans plusieurs parties de l'Angleterre et autres endroits, mais à cause de l'incendie chez les fabricants, on ne put les obtenir à temps. En se servant de machines à action directe on aurait rendu l'installation encore plus compacte, mais même



Details of the Crompton Low-Tension Dynamo.

still more compact, but even as it is the space occupied is very small for the output, being only 23ft. by 16ft. (7 metres by 5 metres), and occupying, therefore, a surface of not more than 368 square feet.

The dynamos comprise two high-tension machines of 32 units, giving 1,280 volts and 25 amperes at 1,200 revolutions per minute, used for the large arc lamps in series; and four low-tension compound-wound machines of 22 units, giving 220 volts and 100 amperes at 1,000 revolutions, used partly for the smaller arc lamps and partly for the incandescents. The central engine drives two of the low-tension dynamos, while each of the side engines drives one high and one low-tension dynamo. In ordinary working the central engine and one of the side engines are used to supply the circuits. By this arrangement one engine and two dynamos are kept standing as a reserve in case of emergency. These dynamos are of the same type as used

telle qu'elle est l'espace occupée est très petite, si l'on considère le rendu, étant seulement de 7 mètres par 5 mètres et n'occupant par conséquent qu'une surface de 35 mètres carrés.

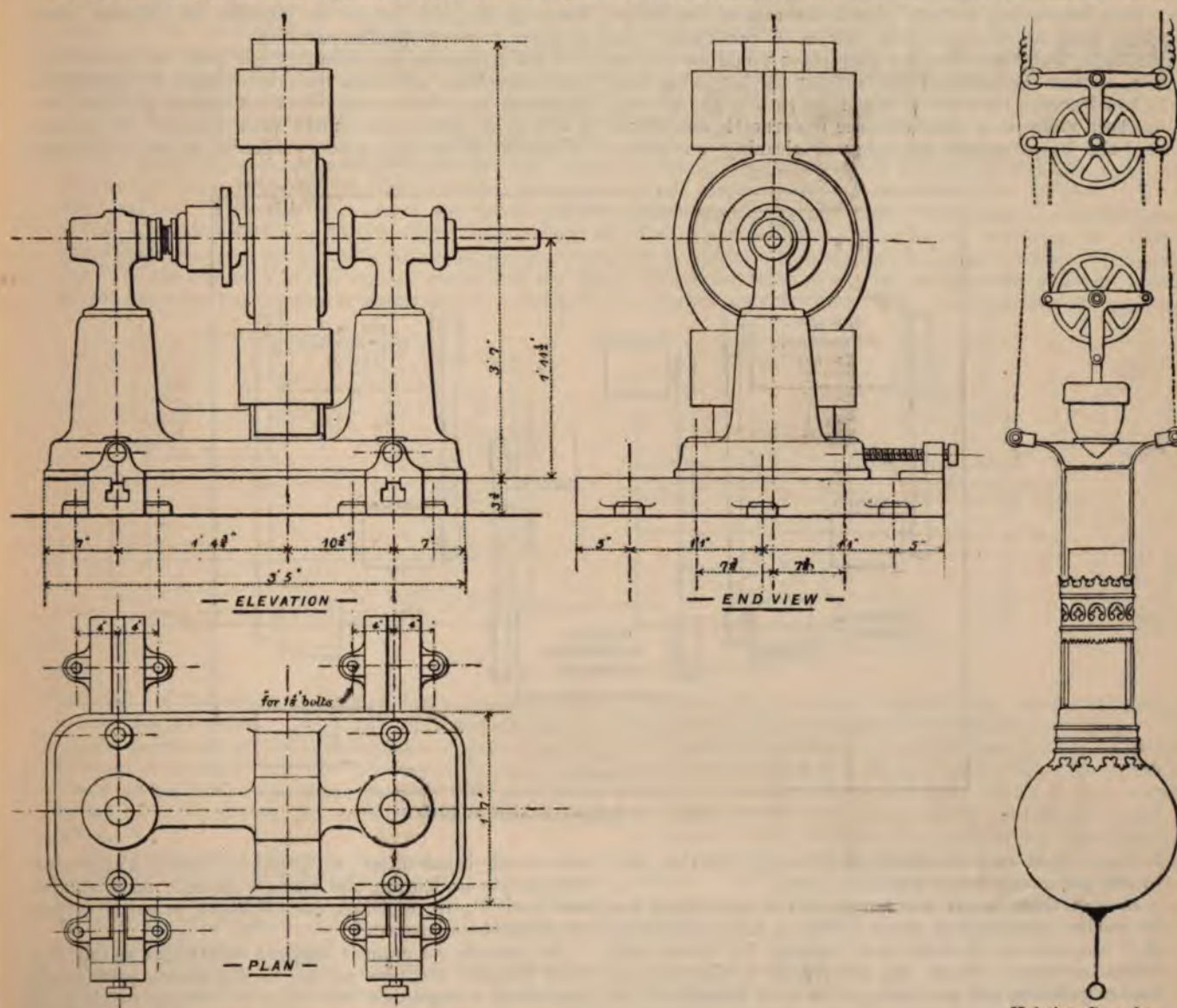
Les dynamos comprennent deux machines à haute tension de 32 unités, donnant 1,280 voltes et 25 ampères, à 1,200 révolutions à la minute, employées pour les grandes lampes à arc, en série; et quatre machines "compound-wound" à basse tension, de 22 unités, donnant 220 voltes et 100 ampères, à 1,000 révolutions, servent en partie pour les plus petites lampes à arc et en partie pour les incandescents. La machine centrale fait marcher deux dynamos à basse-tension, pendant que chacune des machines des côtés fait marcher un dynamo à basse et un à haute tension. Pour un travail ordinaire une machine centrale et une de côté servent à fournir les circuits. Avec cet arrangement une machine à vapeur et deux dynamos sont

by Messrs. Crompton and Co. in fitting up Buckingham Palace, Windsor Castle, the Royal Courts of Justice, London, the Court Theatre of Vienna, the central station at Kensington and Knightsbridge, London, and other places.

In the Exhibition Messrs. Crompton have 24 large arc lamps of the type called D.D. (double differential); these are of 8,000 nominal c.p. (800 carrels), taking 25 amperes, and are run all in series from one of the high-tension dynamos. They are disposed in four rows of five each and one row of four, down the corridors of the Palais des Machines, and are suspended from the girders of the roof at a height of 50ft. from the ground. These arc lamps are supplied with positive carbons of 20 millimetre diameter, and negative carbons of 30 millimetres, and run for 12 hours, giving a very brilliant light.

reservés en cas de besoin. Ces dynamos sont du même type dont se servent Crompton et Cie. à Buckingham Palace, Windsor Castle, Les Cours Royales de Justice à Londres, Le Théâtre de la Cour, à Vienne, la station centrale à Kensington et Knightsbridge, Londres, et quelques autres endroits.

A l'exposition les MM. Crompton ont 24 grandes lampes à arc du type appelé D.D. (double différentielles); celles-ci sont de 8,000 bougies (800 carrels), prenant 25 ampères, et sont toutes en série sur un des dynamos à haute-tension. On les a disposées en quatre rangées de cinq chacune, et une rangée de quatre, le long des corridors du Palais des Machines et elles sont suspendues aux traverses du toit à une hauteur de 15 mètres de la terre. Ces lampes à arc sont pourvues de charbons positifs de 20 millimètres de diamètre et de charbons négatifs de 30 millimètres, et brûlent pendant



Details of the Crompton High-Tension Dynamo.

Hoisting Gear for Crompton Arc Lamps.

The globes are of ground glass, 2ft. in diameter. The circuit is about 1,000 yards long, and is run with a conducting cable of seven strands of No. 17 B.W.G. insulated.

An ingenious arrangement is adopted for raising and lowering the arc lamps, which has been much admired by French electrical engineers. It is similar to that employed by Messrs. Crompton and Co., in 1882, at the Mansion House, London, and saves all trouble with slack wire in suspending the lamps. A cross-bar, furnished with a pulley wheel, is suspended, in the first instance, by steel wires from the girders, and the ordinary conducting cable is connected to porcelain insulators upon the arms of this cross-bar. A long flexible cable is joined to the main cable at the point, and passes around two pulley-wheels, the upper one fixed, and the lower one free to rise or fall, carrying a counterweight to balance the lamp. The cable, is

12 heures, donnant une lumière très-brillante. Les globes sont en verre dépoli, d'un diamètre de 60 cm. Le circuit est d'environ 1,000 mètres de longueur; et est desservi par un cable conducteur de sept cordons du No. 17 B.W.G. isolé.

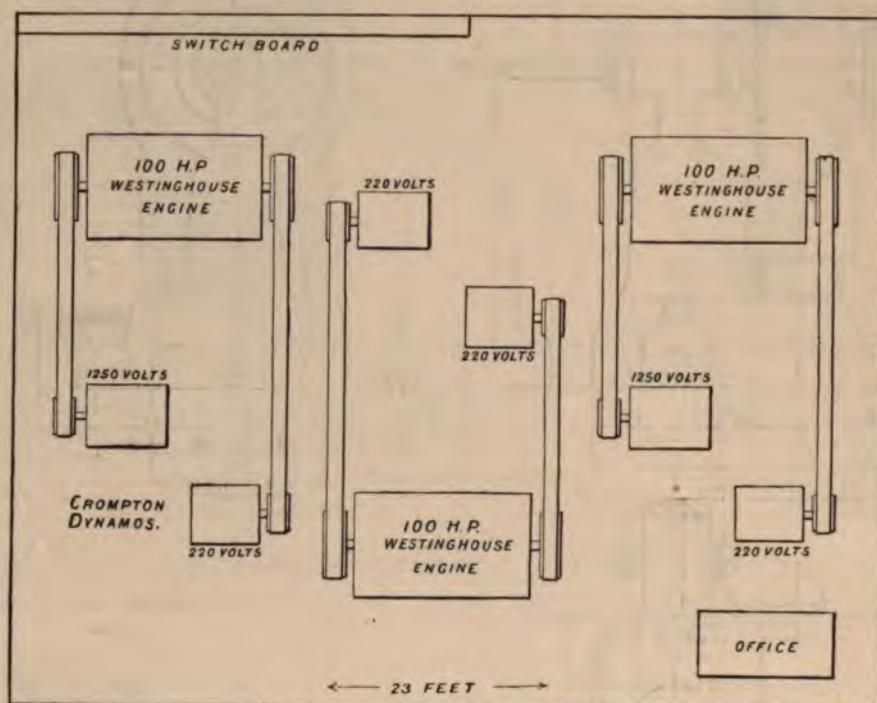
On a adopté un arrangement ingénieux, que les mécaniciens français ont beaucoup admiré, pour élever et abaisser les lampes à arc. Il est semblable à celui que MM. Crompton et Cie. ont employé en 1882, à Mansion House, Londres, et évite tout l'embarras des fils lâches en suspendant les lampes. Une traverse, munie d'une poulie, est suspendue, d'abord, avec des fils d'acier, attachés aux traverses de la charpente, et le cable conducteur ordinaire est joint aux isoloirs de porcelaine sur les bras de la traverse. On joint un cable long et flexible au bout du cable principal, qui passe sur deux poulies, la supérieure fixe, et l'inférieure

brought down again and fastened to one terminal of the lamp. A second flexible cable passes similarly in the opposite direction, and is connected to the other terminal of the lamp. In this manner the slack wire is taken up by the counterweight, in the manner of double-purchase gear. The cable passing over the pulleys is of a special make of flexible wire, manufactured by Messrs. Glover and Co., of Manchester, consisting of 98 strands of fine copper wire (No. 26 B.W.G.), the insulation being similar to that of the main cable, but somewhat thicker, consisting of cotton, two layers of pure rubber, and an outer layer of cotton, braided and ozokerited. Some linen warps are inserted between the rubber and the outer braiding, with the view of increasing the tensile strength and of taking some of the strain of the weight of the lamp from the copper conductor. A cord hangs down from the arc lamp, by which it is lowered for cleaning and renewal of carbons.

It is interesting to note that in the case of the lamps which hang above the rolling bridge of the Palais des Machines, and where the hanging ropes would be in the way, another arrangement for lowering the lamps has had to be adopted. On each of these lamps a large iron ring has been hung at a short distance underneath, and whenever the lamps require trimming or cleaning, an arrow

libre pour s'élever ou s'abaisser, portant un contre-poids pour balancer la lampe. On abaisse de nouveau le cable, et on l'attache à une extrémité de la lampe. Un second cable flexible passe semblablement dans une direction opposée, et est joint à l'autre extrémité de la lampe. De cette manière le fil lâche se trouve enlevé par le contre poids d'un attirail à deux fins. Le cable qui passe sur les poulies est d'une fabrication spéciale, de fil flexible, fait par Glover et Cie., de Manchester, et se compose de 98 cordons de fil de cuivre fin ($\frac{1}{100}$ mm. de diamètre) dont l'isolation est semblable à celle du cable principal, mais un peu plus épaisse, et se compose de coton, de deux couches de gutta-percha, et d'une couche extérieure de coton, tressée et préparée avec de l'ozokérite. On a inséré quelques fils de lin entre le gutta-percha et la tresse extérieure afin d'augmenter la force de tension et d'enlever un peu du poids de la lampe au conducteur de cuivre. Une corde est suspendue à la lampe à arc, au moyen de laquelle on l'abaisse pour nettoyer et renouveler les carbones.

Il est intéressant de remarquer que pour les lampes qui sont suspendues au-dessus du pont roulant du Palais des Machines, et où les cordes pendantes seraient gênantes, on a adopté un autre arrangement pour abaisser les lampes. A chacune de ces lampes on a suspendu, un peu en dessous,



Plan of Messrs. Crompton's Exhibit at Paris.

having a light cord attached is shot through the ring, and by this means the lamps are drawn down.

Besides these larger arc lamps in the roof, there are 79 smaller arc lamps of about 1,000 c.p. taking a current of 8 amperes at 50 volts, and running 16 hours with 13mm. carbons. These are distributed in the top and bottom galleries, and are arranged on four circuits of 18 lamps each, and one circuit of 7 lamps, taken in parallel off the mains of the low-tension machines. The main conductors are 19/16 cable, and the branches to each circuit 7/18 cable. The whole of the arc lamps are fitted with automatic cut-outs, so that any accident to one lamp does not disarrange the circuit; and the branches are also protected at either end by fusible cut-outs. The arc lamps on the top gallery are made to lower by a simple cord and pulley arrangement, while those for the lower gallery are fixed to the ceiling.

There are also 164 incandescent lamps of 16 c.p. working off the same dynamos, in two circuits of 82 lamps each at 107 volts. They are mounted on large pillar electroliers at the foot of the two staircases leading from the vestibule to the top galleries of the Palais des Machines.

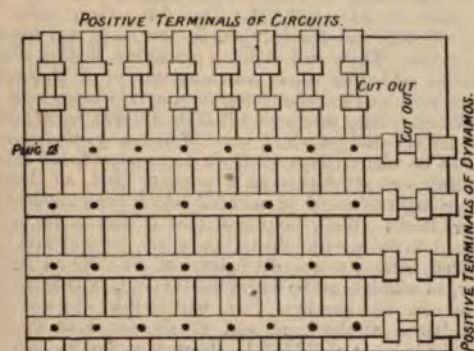
In the way of distribution of power there are also several electric motors of 1 or 2 h.p. supplied from the same installation, and used in the Exhibition for driving purposes.

une grande bague de fer; et, quand on a besoin d'ajuster ou de nettoyer les lampes, une flèche à laquelle on a attaché une corde légère, est lancée dans la bague, et par ce moyen on descend les lampes.

En outre de ces grandes lampes à arc attachés au toit, il y a 79 lampes à arc, plus petites, de 100 carcelles prenant un courant de 8 ampères à 50 voltes, et brûlant pendant 16 heures avec les charbons de 13 millimètres. Ceux-ci sont distribués dans les galeries du haut et du bas, et sont arrangées sur quatre circuits de 18 lampes chacun, et un circuit de 7 lampes, pris parallèlement aux principaux cables des machines à basse tension. Les cables de circuit sont des torons de 19 fils de $\frac{1}{100}$ millimètres, les branchements sont des torons de 7 fils de $\frac{1}{100}$ mm. Toutes les lampes à arc sont pourvues de coupe-circuits automatiques, de sorte qu'un accident à une lampe ne dérange pas le circuit; et les embranchements sont aussi protégés à chaque extrémité avec des coupe-circuits fusibles. Les lampes à arc de la galerie du haut s'abaissent avec une corde simple et un arrangement de poulies, pendant que celles de la galerie du bas sont fixées au plafond.

Il y a aussi 164 lampes incandescentes de 16 bougies se travaillant des mêmes dynamos, en deux circuits de 82 lampes chacun à 107 voltes. On les a montées sur de grands piliers électroliers au bas de deux escaliers qui con-

The switchboard is a very complete piece of apparatus for distribution of the currents, and allows dynamos, by means of plugs, to be coupled together and connected to any circuit as desirable, and also allows the insertion of measuring instruments in any dynamo circuit. The switchboard consists of two parts—the negative and the positive. On the first all the positive poles of the dynamos are connected to two horizontal copper bars raised slightly above the switchboard, and pierced with plug-holes. The eight circuits to the lamps are connected to eight copper bars passing under the first ones in a vertical direction, and similarly pierced. By inserting a plug in any hole of the first bar, dynamo No. 1 is connected to the copper bar passing below it, and so on with the others. The connection of each circuit to the copper bars is protected by a main fuse. In the second or negative part of the switchboard the arrangements allow of each circuit, or each dynamo, being connected to an ampere-meter by the movement of a switch-handle. Three main copper bars are fixed horizontally. Eight two-way switches above these receive the return ends from the lamp circuits, protected, as before, by a fusible cut-out. Four two-way switches below the bars receive the negative ends of the cables from the four dynamos, equally protected with cut-outs. All the circuit switches are connected one way to the centre bar, and all the dynamo switches are connected one way to the same bar. The other junctions of the circuit switches are all connected to the top bar; and all the junctions of the dynamo switches are similarly connected to the bottom bar. To the terminals of the top and centre bar are connected the wires leading to one ampere-meter; and to the



duisent du vestibule à la galerie supérieure du Palais des Machines.

En fait de distribution de force il y a aussi plusieurs moteurs électriques d'un et deux chevaux, qui s'approvisionnent à la même installation, et s'emploient dans l'Exposition pour faire marcher différents appareils.

Le commutateur pour la distribution des courants est un appareil très complet, et permet de coupler les dynamos, au moyen de tampons, et de les joindre à un circuit quelconque, à volonté; cela permet aussi l'insertion d'instruments à mesure dans un circuit de dynamo. Le commutateur consiste de deux parties, la négative et la positive. Sur la première on a joint tous les pôles positifs des dynamos à deux plaques de cuivre placées horizontalement, élevées au-dessus du commutateur et percées de trous à tampons. Les huit circuits des lampes sont joints à huit plaques de cuivre passant sous les premières dans une direction verticale, et percées semblablement. En insérant un tampon dans un trou quelconque de la première plaque le dynamo No. 1 est joint à la plaque de cuivre qui passe dessous, et ainsi de suite avec les autres.

La connexion de chaque circuit aux plaques de cuivre est protégée avec une fuse principale. Dans la seconde ou partie négative du commutateur les arrangements permettent à chaque circuit ou à chaque dynamo, de se joindre à un ampèremètre au moyen d'une poignée. Trois principales plaques de cuivre sont fixées horizontalement. Huit commutateurs à deux voies au-dessus de celles-ci reçoivent les fils de retour des circuits des lampes, protégées comme auparavant par un coupe-circuit fusible. Quatre commutateurs à deux voies, au dessous des plaques,

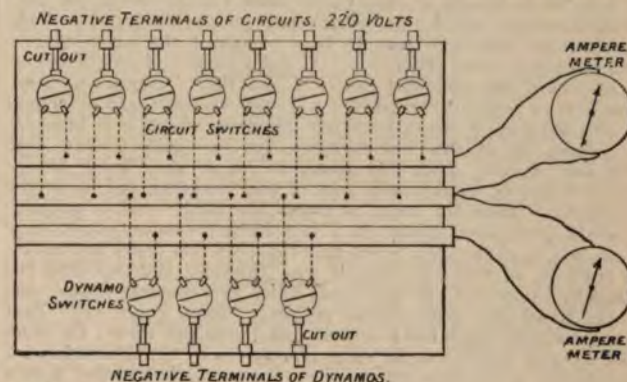


Diagram of Crompton's Switchboard.

terminals of the centre and bottom bar, those leading to a second ampere-meter. With this arrangement, by the simple movement of the switches, the current from any dynamo, or in any circuit, can be immediately noted. The whole switchboard is a very complete and satisfactory means of manipulating the currents from such an installation.

The switches are of Crompton's patent pattern, composed of a brush built up of fine stencil copper. This construction affords an exceptionally good surface while rubbing against the contact-pieces, and has also the advantage of being renewable at very small cost.

Messrs. Crompton and Co.'s installation exhibits a very compact and carefully thought-out system, showing the combined distribution of arc lamps, in series and in parallel, of incandescent light and of motive power, with simple and easily understood arrangements for control, comprised in a remarkably small space for an installation of such a capacity. The practical working arrangements adopted are well worth attention by intending undertakers of central installations.

Lighting after Midnight.—The Sperry Electric Company, of Chicago, by means of an ingenious device are enabled to operate their 10 ampere lamps on a current of only five or six amperes without causing the slightest hissing in the lamp or sparking at the brushes. The arrangement enables local lighting companies having city contracts to satisfactorily run the street lighting after midnight at a lower brilliancy at a reduction of 40 per cent. to 50 per cent. in the matter of fuel.

reçoivent les extrémités négatifs des cables des quatre dynamos également protégés avec des coupe-circuits.

Tous les commutateurs de circuit sont joints d'un côté à la plaque du centre, et tous les commutateurs de dynamo sont joints d'un côté à la même plaque. Les autres jonctions des commutateurs de circuit sont toutes jointes à la plaque du haut, et toutes les jonctions des commutateurs de dynamo sont jointes semblablement à la plaque du dessous. On a joint les fils conduisant à un des ampèremètres aux extrémités de la plaque de dessus et la plaque centrale, et ceux conduisant au second ampèremètre aux extrémités de la plaque centrale et de dessous.

Avec cet arrangement, par un simple mouvement des commutateurs, le courant d'un dynamo quelconque, ou sur n'importe quel circuit, peut être immédiatement mis en évidence. Cet arrangement de commutations est un moyen très complet et satisfaisant pour manipuler les courants d'une telle installation.

Les commutateurs sont d'après le modèle breveté de Crompton, avec une brosse bâtie de minces lames de cuivre. Cette construction donne une surface exceptionnellement bonne en frottant contre les pièces de contact, et à aussi l'avantage de pouvoir se renouveler à bas prix.

L'installation de Crompton et Cie. présente un système très compact et soigneusement arrangé, montrant la distribution combinée des lampes à arc, en séries et en parallèles, de la lumière incandescente, et de la force motive, avec des arrangements simples et faciles à comprendre et à contrôler, contenus dans un espace remarquablement petit, pour une installation d'une telle capacité. La manipulation des arrangements pratiques adoptés valent bien l'attention des entrepreneurs d'installations centrales.

COMPANIES' MEETINGS.

EDISON AND SWAN ELECTRIC LIGHT COMPANY.

The sixth annual general meeting of the shareholders of the Edison and Swan United Electric Light Company, Limited, was held on Wednesday at the City Terminus Hotel, Cannon-street, E.C., Mr. James Staats Forbes presiding.

The **Chairman**, in moving the adoption of the report, said, in accordance with practice, he would proceed to make a very few remarks to give such elucidation of the figures as they might desire, and also to say a few words on the general subject of the position of the Company. Referring first to the balance-sheet, he said that the debtor side showed that the state of the capital account was quite unaltered, for during the year there had been no additions to capital. The A shares amounted to £353,478, and the B shares to £117,820, the latter being the shares which were allotted to Mr. Edison and his friends, and which stand in the position of deferred shares, and which are not entitled to any dividend until the A shares have received the full amount of 7 per cent. cumulative dividend from the commencement of the Company. The sundry credit balances amounted to £4,711, being, in fact, money to which they were indebted by outsiders; and about that he had to say that it was more favourable than it was last year, when it stood at £10,214. The last item on the debit side of the balance-sheet was not less satisfactory, and was profit and loss as per appropriation account, £44,037, against £45,000 in round figures last year. On the other side of the account they showed what they had to represent that amount of money. They would see, first of all, that the cost of patents, goodwill, preliminary outlay, loss on working, etc., as per last balance-sheet, was £274,999. During the year they had expended upon that account £13,899 in addition, but they had realised in diminution of that by sale of plant, and other sums which they had to receive, £12,560. Thus, they had thought it a prudent thing to disburse that account by £12,000 which they held in the Manchester Company under an agreement, and that appeared lower down in the account. The next item was the further deduction of losses on realisation of sundry installations taken over at the date of amalgamation, and heretofore reckoned up in capital outlays. Well, the Directors had, from time to time, explained the nature of that business when it was taken over. It had a number of very good elements, but it had some very bad ones, and their business had been, from year to year, to eliminate the bad from the good, and to charge to the working of the undertaking the losses which were involved in getting rid of this bad bargain. He was glad to say that this last writing down had come, as far as they knew, to the end of that very unfavourable side of their business, and he would like them to realise the effect of that. The asset, "cost of patents, goodwill, preliminary outlay, etc.," is rather in the nature of not being a concrete tangible thing, which they could sell like tables and chairs, or anything of that sort, and it was, therefore, different from the items that they found set out below, which were concrete things, such as the Manchester Edison-Swan property, offices, plant, etc. That was something which had a current and immediate value; the other had a value, but it was the value represented by the dividend which they would be able from time to time to pay upon their capital upon a going concern in which they were embarked. If they would cast their eyes over the accounts, they would find that the cost of patents, etc., as per last balance, was £274,991; whereas, if they looked further down the page, they would find that they were reduced to £235,614, or that they were £39,377 less than they were, and to that extent the Company was better off. He supposed that as a matter of fact they were still worth what they stood at in the balance-sheet. But if they were worth £274,000 it was much better than that amount should be £39,000 less in figures, because the value did not diminish, while upon the other hypothesis if they were not worth as much they were so much the better off. That was what he called a living asset. The Manchester Edison-Swan Company's shares, £12,000, was not a particularly productive asset at the present moment, because it stood in the same category as the shares paid to Mr. Edison, £117,000. It was different to the capital provided by the Manchester Company for establishing their business, but some day or other one might hope that in this electric light company, which was showing signs of great expansion, that that which was not a very promising asset might in the future be a very valuable one. He thought their own shares were pretty good illustrations of that point. In two or three years their position had so greatly changed that they were able to meet under circumstances much more gratifying to the Directors and the shareholders than on any former occasions. Of the other items in the accounts, the investments were £27,500, and were all well invested, and their freehold property appeared in the balance-sheet at £27,991. That covered the land and factory where they now manufactured the bulk of their lamps at Ponders End, at Green-street, and the remnant of a factory at Newcastle. The plant and stock appeared at £40,406. Of course, their factories were fitted up in plant and stock, and they had in hand from half-year to half-year a great deal of tangible concrete value in that form. Of course, the value of such things depended upon their being a part of a going concern. If one had to anticipate the possibility of the business stock and of those appliances being thrown out of gear, they might not be worth 20s. in the pound, but as parts of a going concern they were certainly not over-estimated at that price. The item of office furniture was very small, and was being written down from year to year, and he dared say the time would not be far distant when they would redeem it. The debtors appeared in the accounts as £29,221, and they believed they were all good debts, while the cash at bankers and in hand stood at £29,206. Compared with the corresponding

valuations in money in hand last year, that item had increased. It stood last year at £125,800, but it was now £166,610, and therefore they were, in round numbers, about £41,000 to the good. He thought, therefore, they might congratulate themselves upon a balance-sheet which was highly satisfactory, and which represented the full value of the debits on the opposite page. Referring, next, to the profit and loss account, he was happy to be able to congratulate the shareholders on the realisation of what had been predicted from time to time—that this business of theirs only wanted time to develop rapidly. It had developed with some rapidity during the last year. They would remember that in the preceding year they showed not an inconsiderable advantage, having realised about £25,000. The reasons, which they explained at the time, and which the judgment of the proprietors approved then, as he dared say they did now, it was not distributed, but kept in reserve. As compared with that figure, this year the profit was much larger. Mr. Forbes then went through the items on the debit side. The stock on hand, which meant lamps and the materials connected with the manufacture of lamps, as distinguished from the value of plant in the factory itself, he said, was £19,590. The wages, purchase cost of installations, stood at £62,529; the salaries, directors' fees, rent, office expenses, etc., £8,562. Then there was a small item of a special character which would disappear from their account in future—namely, Mr. Swan's salary, as Mr. Swan's particular bargain with the Company had terminated. The next item was depreciation of plant, £1,394. 7s. 5d., which was the money they had written down on estimated value of plant from year to year. The reserve for Manchester Edison-Swan Company, which came next in the account, was a small amount of money in the nature of damages they had received, and then came the income-tax. On the other side of the account for sales of lamps, fittings, and charges for work done was £111,000; interest, etc., £1,047. 13s. 9d. Messrs. Davidson and others £2,140, which was rather in the nature of an accidental item of damages, or results of a litigation paid by a gentleman, who, having infringed their lamps, and been found guilty, had to pay the penalty in the nature of royalties on the lamps that they had sold, £2,140. Then the stock on June 30, 1889, £25,985, or £6,000 more than last year. The stock of lamps must in the very nature of things increase from year to year when their business increased. The value of their business this year was £112,763, but last year it was £88,404. Therefore, their sales had increased by £24,000, and the increase in the stock was about in the same proportion. There was rather a gratifying feature about that. He had often said that their business was of a character which involved, as compared to other businesses, a very large sum for fixed charges. Whether they produced 100,000, 200,000, or 300,000 lamps, there were certain charges which were, of necessity, the same, such as rent, interest on the outlays at their factories, official salaries and things of that sort, all charges of a general kind, as distinguished from those charges of wages or material which were incidental to the manufacture itself. Well, looking at that it was so far satisfactory. Turning next to the paragraphs in the report, he said that paragraph 2 showed that there was a credit balance of £47,729 on the working of the year, to which must be added the sum of £25,123, the balance of the account for the previous year, which they did not divide for reasons explained at the time, and it showed how the Directors dealt with the balance of £72,852. They were face to face with the question for the first time, practically of a distribution of a dividend, and a distribution of a dividend in joint-stock companies was not without its thorny places as far as the responsibility of the Directors went. They were, like other trustees, subject to the consequences of their action. There was so much litigation, and so much partially made law as to what was capital and what was profit, they had been obliged to be very particular indeed, in consideration of those matters from year to year. Of course, it was more or less abstract, for there really was no settled law upon these subjects by which the Directors could stand; and they were in the unfortunate position of having to determine what they ought to do in justice to the shareholders, and for their own protection as trustees. Well, they had thought it judicious to write down everything in the nature of a loss which had accrued since that business was initiated. They went into it with their eyes open, and they knew that there were some bad bargains, and they knew that the sooner that they got out of them the better. Then they had from time to time a considerable amount written down in virtue of that loss in the earlier years of 1884, 1885, and 1886. Certain of those losses remained in the capital account as cost of patents, goodwill, preliminary expenses, outlay, loss on working, etc. They had eliminated everyone of those things by appropriating £28,815, which, so far as they could ascertain at present, was the last item which was likely to trouble them under the head of loss. To meet that loss, in conformity with the discretion invested in the Board, they had done what was exceedingly prudent as men of business, and which he was sure would commend itself to the judgment of the shareholders. They had done it this year, because they could afford to do it. They had also created a reserve of £4,595. 10s. 10d., and they recommended the appropriation for dividend, in accordance with clause 87 of the articles of association, of 7 per cent. upon the amount paid up on the A shares, in respect of the year ending June 30, 1889, and of 3 per cent. further on account of the arrears of preferential dividend on the A shares in respect of the year ending June 30, 1884. So that that dividend was not a dividend resting on the profits of that particular year, but it was an accumulated dividend. Therefore, where in any year the profits were not sufficient to pay 7 per cent. the balance became a charge on the extra profits of future years, and, if they were familiar with the old report they would remember that they had continually brought to the knowledge of the proprietors that the B shares were entitled to a quarter of the profits after 7 per cent. was paid on the A shares of the accumulated preferential dividend. Having exhausted the purse as far as the 7 per cent. required it, there was still enough left

to wipe out some of the arrears of accumulation, and upon that they proposed to add a further 3 per cent. on account of the accumulated preferential dividend in respect of the A shares for the year ending June 30, 1884, so that the dividend was 10 per cent. But what they wanted to impress on the proprietors was that they were not entitled to receive more than 7 per cent. in any particular year; but that 3 per cent. was coming back into their pockets to pay up old scores. He must, however, qualify what he had said, for if the arrears were wiped out, and if the business progressed in anything like its present ratio, next year that 3 per cent. would be larger; 7 per cent. might not increase in amount, but 3 per cent. would. But, assuming it to be worked out in the course of a few years, then the A shares stood in this position up to 7 per cent.—they took the first fruits, and over 7 per cent. they participated *pro rata* with the B shares. With regard to the fourth paragraph in the report, everyone knew that in the few years that had elapsed since the initiation of this Company they had gone through a great many troubles. They were in litigation and had to defend their patents. They had many people ready to deprive them of the advantages of their inventions if they could do so. He daresay the shareholders had a very little idea of the amount of serious anxiety and responsibility which the decision of these questions threw upon their shoulders, because, although they had a most eminent counsel and the most scientific witnesses, there were always two sides to a question, and great interests being at stake involved great efforts on both sides. Learned counsel told the best story they could, and eminent scientific witnesses gave the best evidence they could; but then the other side told their story, and even learned counsel vacillated in their feelings, and they came to the Directors and those who were watching the proceedings, and said, "We think it is right, but it might not be; now, then, what are you going to do?" He assured them the Directors had a *mauvais quartre d'heure*. There had been a great deal of litigation and, reasonably speaking, they believed that the question of patent rights of that Company were beyond attack. They had succeeded in the Woodhouse-Rawson case, and that was thought to be a great triumph; but since then some of their old friends with new faces had started up on the Brush action. In that case there were conflicting doubts, and there again they had to decide, and the result of their decision was that they got all they went for. If they had not, possibly their position to-day and in the future would be entirely different to what it was, and he doubted whether there would be any dividend whatever to pay. With regard to the Woodhouse suit that cropped up again, and Mr. Justice Kay gave a decision against them in favour of Cheesbrough, and declared Edison to be in fault. That was a dreadful thing for him, and they determined to go on, and they were happy enough—first of all by dint of the goodness of their case, but not the least of all by the splendid ability of the learned gentlemen who conducted their case, and especially the Attorney-General—they were successful in a very strong court of appeal in a most conspicuous way. Well, then, of course, the Brush Company did not like to be beaten, and they reserved the right to appeal to the House of Lords, and they were very confident. He knew something of the House of Lords, and he had most recently been a defendant in a suit, and had to fight a case there, not because he believed in it, but because statistics showed that in every 100 appeals in the House of Lords from the Court of Appeal 33 were reversed, and so his friends and his masters, in some sense, insisted upon fighting—a thing which was hopeless, but for the chance that they might be one of the 33. He did not know whether the Brush Company were actuated by the same logic; but there was the chance of having their position greatly damaged by that appeal. But, happily, wise counsels prevailed, and they, having established their rights, were not particularly anxious to use them either harshly or ungenerously. The Brush Company, they thought, might help them in the future, and therefore they did not go in for exacting terms, and they made something in the nature of a compromise, highly satisfactory to them and the Brush Company. They ceased to make lamps, and they had handed over to them for what they were worth the benefit of certain patents of theirs, and they had paid the taxed costs of the litigation. He thought it was a good solution of that matter, and hoped they would not hear anything more of the litigation in that shape. He would like to impress upon their absent friends the fact that, but for the forbearance and confidence of the shareholders, it would have been impossible for the Board to feel that confidence in their case which had carried them through this litigation, and, therefore, they were all being rewarded. The shareholders were being rewarded for the confidence in the Board, and the Board were being rewarded on the satisfaction that their judgment, hard work, and anxiety had resulted in their undertaking being put on a perfectly safe ground, and their property being likely to be a very profitable enterprise. In concluding, Mr. Forbes referred to the item which appeared in the accounts for the first time with regard to the Directors' fees (£4,093), to which, he said, they were entitled under the 62nd clause of the articles of association. The Company was formed, he said, on a basis almost uniform in joint-stock companies, so that the Directors were, in fact, partners in the profits, and when the profits exceeded a certain figure they participated. As that was the first time the question was raised he thought it was only right that the proprietors should understand it. Having read the clause, the Chairman pointed out that during the earlier days of the Company they had only accepted half the fees to which they were entitled, because the Company was poor; but now it was becoming rich, they thought they were entitled to them. He then moved the adoption of the report and accounts.

Mr. F. R. Leylands, in seconding the motion, congratulated the proprietors on the position of the Company. Comparing the present position of the Company with its position in 1884, he said that at the latter period the management expenses were £26,350, but they were now only £8,562. They started in 1884 with a loss of £28,814, and now they had a net profit of £47,729. In addition to bringing down

expenses, they had wiped off old losses, and also fought the battles of the Company. The patents had now been thoroughly fought out, and he did not think there was the slightest chance of their being fought again. With regard to their arrangement with the Brush Company, he thought it right to tell them that the Board had given up nothing, but they had agreed not to sue them for the profits that they had made by the infringement; and, on the other hand, the Brush Company had paid them their taxed costs. Then the Brush Company had commenced an action against them for some alleged infringement of some patent that they held. They did not think that there was much in that, but they thought it a very desirable thing to have no further litigation, and they had agreed to take a license of all the patents that they held of any description at a royalty of one farthing a lamp, and on the lamps they made, and a further stipulation that the royalties were never in any one year to exceed a sum of £375.

After some congratulatory remarks from Sir John Lubbock, M.P., the report was adopted, and the dividends recommended agreed to.

The retiring officers having been elected,

The Chairman announced that Mr. Edison was going to visit Europe very soon, and he hoped to induce him to visit London, where he would no doubt receive such a welcome as this great inventor deserved.

A vote of thanks was then accorded to the Chairman, which closed the proceedings.

THE GLOBE TELEGRAPH AND TRUST COMPANY.

The sixteenth ordinary general meeting of this Company was held on Tuesday at Winchester House, Old Broad-street, Sir John Pender presiding.

The Chairman said he thought that the report would be regarded as favourable on the whole. As he predicted at their last meeting, there had been an improvement in the position of the companies in which they were interested, and upon whom they were dependent for their dividend. Owing to the acquisition by the German Government of the German submarine telegraph system, the Company had had to realise the investment they had held in that undertaking. They had obtained a good profit on the change being made, and the money had been reinvested in equally satisfactory securities, which, on the whole, would yield rather a larger return. The most favourable point he had to mention was that the Anglo-American Company was now earning a fair dividend, the shilling tariff having given them twice as much as they had previously obtained with the sixpenny rate. The public had accepted the shilling tariff as a fair and moderate rate. The Eastern and Eastern Extension Companies had paid increased bonuses. He looked forward with considerable hope to the continuance of the prosperity which the submarine telegraph companies were now enjoying. They had invested nearly £50,000 in the Western Union Company of America, having acquired their shares in that company at 84. They bore 5 per cent. interest, and had the guarantee of the Western Union Company, so he considered the investment a very safe though not a home one. With reference to the rumour of another cable being about to be laid in the Atlantic, to go to Canada, there were already 10 Atlantic cables, whereas eight could easily do all the work that was required. The completion since their last meeting of the West African system had marked the carrying out of one of the most remarkable among the many remarkable achievements in submarine telegraphy, Africa having now been completely surrounded with cables. He concluded by moving a resolution for the adoption of the report and the payment of dividends of 3s. a share on the preference shares, and 4s. a share on the ordinary shares, making, with previous distributions, 6 per cent., less income-tax, on the preference shares, and 4½ per cent. net (against 3½ per cent. in the previous year) on the ordinary shares.

The Marquis of Tweeddale seconded the motion, which was adopted, and the retiring Directors and Auditors were afterwards re-elected.

690004

DIRECT UNITED STATES CABLE COMPANY

The twenty-fourth ordinary general meeting of this Company was held on Friday at Winchester House, Old Broad-street.

Sir John Pender, who presided, stated that the revenue for the half-year to the 30th ult., including income-tax refunded, and after deducting out-payments, had been £39,626, and the working and other expenses, including income-tax but exclusive of the cost of repairs, had been £16,676. The net profit for the half-year had been £22,950, which was increased by the balance brought forward to £34,592. Two interim dividends of 3s. 6d. a share each had been paid for the quarters ended December 31 and March 31, and a final dividend of similar amount was proposed for the quarter ended 30th ult., leaving a balance to carry forward of £2,719. The revenue for the half-year at the shilling rate showed an increase as compared with that of the corresponding period of last year of £22,118, but the tariff was then only 6d. a word. The June half-year was always less productive than the December half-year, and it was hoped that the increase noticed in the traffic might continue, when a much better result might not unreasonably be looked for. On April 19 last the main cable was broken on the Green Bank through the fouling of the cable by a vessel's anchor. Application was immediately made for the use of the Anglo-American Company's steamship "Minia" to repair it, but she was found to be unavailable. A speedy restoration of communication being of the greatest importance the Telegraph Construction Company's steamship "Britannia" was at once despatched to the position of the break, and restored the cable on the 19th May at a total cost, including cable used, of £4,474. A portion of the cable picked up during this repair was found in excellent condition, after its 16 years' submersion. The reserve fund account, after being credited with interest on the investments and profit on sales of securities, and debited with cost of repairs, now amounted to £242,048. It was not on that occasion proposed to further

690004

increase the reserve fund, but it was hoped that in future that account might be regularly increased by transfers out of revenue. The investments were worth much more than their cost price, at which they stood in the balance-sheet. Dr. Muirhead, in a letter dated the 25th inst., stated that he had no hesitation in giving it as his opinion that the main cable of the Company was, electrically speaking, practically as perfect now as it had ever been. At one time they said that ten years was something like the average "life" of a cable, but he thought they might with as much confidence say 20 years now, and he might, perhaps, go even beyond that. The shilling tariff was earning just double the money they received at the sixpenny rate. That was a very satisfactory feature, but still, with the shilling tariff, sufficient money was not being earned to satisfy the excess of submarine cables now in the Atlantic. If the last two cables had not been laid he thought they would now be in a very satisfactory position with the shilling tariff, which he saw no chance of being altered. He believed with the growth of telegraphy that there would be work for the ten cables in the Atlantic, though to meet present requirements only eight were needed. The law case in connection with the French company was still going on. Since the removal of the cable from Brown's Bank to Halifax they had had no interruption in it. He concluded by moving a resolution for the adoption of the report and the payment of the dividend recommended, making 3½ per cent. for the year ending the 30th ult., afterwards observing that the shilling tariff had not been in operation the whole year, the sixpenny rate having been in force for two months.

Mr. Wm. Ford seconded the motion, which was adopted.

A discussion followed relative to the re-election as directors of Admiral the Hon. Sir Henry Keppel and Admiral Mayne, C.B., M.P., Mr. Guerdon contending that five Directors of the Company would be ample.

The Chairman, in reply, stated that not merely the question of management was involved in the number of Directors, but the question of the shareholders having a proper representation.

The retiring Directors were eventually re-elected by an overwhelming majority.

NEW COMPANIES REGISTERED.

General Electric Company, Limited.—Registered by Tamplin, Tayler, and Joseph, 165, Fenchurch-street, E.C., with a capital of £60,000, divided into 7,000 first preference shares, 1,000 second preference shares, and 4,000 ordinary shares of £5 each. Object: to acquire and take over, as going concerns, the business carried on under the style of the General Electric Company, at 71, Queen-Victoria-street, E.C.; 22, 23, and 24, Garlick-hill, E.C., and 71 and 73, Bentham-road, South Hackney, in the county of Middlesex; also the business carried on in Clegg's-court, Chapel-street, Salford, in the county of Lancaster, under the style of the Manchester Electric Works Company, and the several patents, goodwill and other assets of the proprietors of such businesses, and with a view thereto to enter into two agreements mentioned in clause 3 of the Company's articles of association, and to carry the same into effect with or without alteration. The first subscribers are:

	Shares.
G. Binswanger, 71, Queen-Victoria-street	2,000
J. H. Ward, 23, Lower Phillimore-place, Kensington.....	3,000
H. Hirst, 71, Queen Victoria-street, E.C.....	1
S. Smith, accountant, 159, Milkwood-road, Herne Hill, S.E....	1
G. S. Joseph, 165, Fenchurch-street, E.C.	1
A. R. Bernard, Hillbrow-villas, East Finchley, N.	1
H. Heritage, 7, Wendover-road, Harlesden, N.W.	1

The number of Directors shall not be less than four nor more than nine, and the first shall be Gustav Binswanger, Max Binswanger, and Hugo Hirst, and two Directors to be appointed by John Henry Ward. The two Directors so appointed shall be paid out of the funds of the Company £210 in any year in which the profits of the Company shall be more than sufficient to pay a dividend of 10 per cent. on the capital paid up.

CITY NOTES.

Brush Company.—An extraordinary general meeting of the shareholders of this Company will be held at the office of the Corporation, 112, Belvedere-road, on Wednesday, the 7th inst., at 3 p.m., when the subjoined special resolutions, which were unanimously passed at the extraordinary general meeting on July 22, will be submitted for confirmation as special resolutions: Resolution No. 1. "That it is desirable to reconstruct the Anglo-American Brush Electric Light Corporation, Limited, and that with a view thereto the Corporation be wound up voluntarily, and that J. B. Braithwaite, jun., and E. Garcke be, and they are hereby, appointed liquidators for the purposes of such winding-up." Resolution No. 2. "That the said liquidators be, and they are hereby, authorised to consent, if required, to the registration of a new Company, to be named the Brush Electrical Engineering Company, Limited, with a memorandum and articles of association which have already been prepared with the approval of the Directors of the Corporation, but which are to be subject to such alterations and modifications (if any) as may be found expedient. Resolution No. 3. "That the draft agreement submitted to this meeting and initialled by the Chairman for the transfer of the business and property of this Corporation to the new Company shall be and the same is hereby approved, and that pursuant to section 161 of the Companies Act, 1862, the liquidators shall be, and they are hereby, authorised to enter into an agreement with such new company (when incorporated) in the terms of the said draft and generally to carry the same into effect with such (if any) modifications as the liquidators may find expedient.

PROVISIONAL PATENTS, 1889.

JULY 22.

11636. **Improvements in instruments for detecting and measuring electric currents.** Philip Jolin, 35, Narrow Wine-street, Bristol.

11661. **Improvements in thermo-electric and furnace batteries.** Charles Huelser, 142, Fleet-street, London. (Hugo Mestern, Germany.)

JULY 23.

11705. **Appliances for economising and utilising surplus electricity for lighting, power, and other purposes.** Francis William Engelbach and Edward Brailsford Bright, 11, Howley-place, Maida Hill.

11719. **Improvements in or connected with phonographs.** William Porritt Ingham, 57, Chancery-lane, London.

11732. **Improvements in and relating to electric telegraphs.** Frank Anderson, 45, Southampton-buildings, London. (Complete specification.)

JULY 24.

11755. **An improved method in connection with arc lamps.** John Kent, 9 and 10, Railway-approach, London Bridge.

11780. **Improvements in electric generators.** Charles Edward Buell, 76, Cheapside, London. (Complete specification.)

JULY 25.

11832. **Improvements in junctions or couplers for electrical conductors.** Ernest Richard Dolby, 2, Great George-street, Westminster.

11846. **Method of maintaining the constancy of electrical potential difference in the several branches of distributing network, supplied with either continuous or alternating currents.** Siemens, Brothers, and Co., Limited, 28, Southampton-buildings, London. (The firm of Siemens and Halske, Germany.)

11847. **Improvements in the distribution of electrical energy.** Siemens, Brothers, and Co., Limited, 28, Southampton-buildings, London. (The firm of Siemens and Halske, Germany.)

JULY 26.

11900. **An improved conduit for electric railways.** Madison Dallas, 142, Fleet-street, London. (Complete specification.)

11914. **Improvements in the manufacture of plates for secondary voltaic batteries.** Anthony Reckenzaun, 28, Southampton-buildings, London.

11927. **Machine for covering electrical conductors.** Sydney Pitt, 24, Southampton-buildings, London. (James Bussnet Atherton, United States.) (Complete specification.)

JULY 27.

11941. **Improvements in switch boards for telephone exchange.** Mix and Genest, Limited, Co., and William Oesterreich, 41, Eastcheap.

SPECIFICATIONS PUBLISHED

1883.

10505. **Electric switches.** Rousseau. 8d.
12158. **Working railways by electricity.** Spagnoletti. 8d.
12332. **Electric meters.** Caudey. 8d.
12505. **Joints for electric mains.** De Ferranti. 8d.
12798. **Electrical sounding apparatus.** Vigil and Revueltas. 6d.
12907. **Dynamo-electric machines.** Parker and Lowrie. 11d.
13076. **Electrical signalling apparatus.** Jacob. 8d.

1889.

238. **Dynamo-electric machines.** Gibbs and Fesquet. 8d.
2080. **Medical electric apparatus.** Lake (Stanley). 8d.
3808. **Electric signals for engine shafts.** Rickatson. 8d.
8053. **Electrical signalling.** Imray (Jones and Others). 8d.
8861. **Electric switches.** Imray (Thompson). 6d.
8979. **Electric switches.** Andersen. 6d.
9231. **Regulating electric currents.** Heys (Clark). 6d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.	Name.	Paid.	Price, Wednesday
12 Feb. 1/2	Anglo-American Brush E.L.	—	—
12 Feb. 2/0	— fully paid ..	—	—
14 Nov. 0/4½	Con Telephone & Main ...	1	¾
27 July 10/0	India Rubber, G. P. & Tel.	10	19½d.
.....	House-to-House	4½	4½
.....	Metropn Electric Supply	—	2½
.....	London Electric Supply ...	5	3½
.....	Swan United	3½	4½
12 July 12/0	Telegraph Construction ...	12	43½
2 July 6/0	— 6%, 1889	100	105
29 Nov. 5/0	United Telephone	5	15½

NOTES.

Western Telephones.—Communication is now open between Plymouth and Torquay.

Electrical Profits.—The Continental Edison Company made a profit of £10,482. 12s. in 1888.

Quadruplex Telegraphy.—Quadruplex telegraphy has been introduced between Adelaide and Melbourne. Another wire will shortly be necessary.

Applications.—Out of 176 towns to which notices have been given by electric lighting companies, 66 towns have been notified by companies owing their origin to Mr. Robert Hammond.

Kidsgrove.—At the meeting of the Local Board, a notice by Messrs. Ranshaw and Co. to apply to the Board of Trade for power to light Kidsgrove by electricity was considered, and was left to a special meeting of the Board.

Electric Launches for Royalty.—The Prince and Princess of Wales took a ride in the "Viscountess Bury," Messrs. Immisch's electric launch, a few days ago; and his three daughters and the Earl of Fife were on board the "Raymead," and were greatly pleased with their experience of electric launching.

Electric Cars at Cincinnati.—The Mount Auburn Electric Railway has just been completed at Cincinnati, by the Sprague Company. It is a double track line, four miles long, running from the heart of the city to the Zoological Gardens on the outskirts. Two other electric roads are in process of construction.

Cowpen.—A public experiment was made on Saturday night last by Messrs. Nicholson and Jennings, electricians, of Newcastle and London, who are fitting the electric light at Cowpen, of five lights at Waterloo and Cowpen Quay, and the test, which took place before the Cowpen Local Board, proved satisfactory.

Gas Interests.—The provisional orders for South London have been dropped. "Were they promoted by some parties who wanted gas to be continued?" asks the *Metropolitan*. We hardly think so. There is a good deal of work to be done, and it cannot all be done at once. But it will get done in time, never fear.

New Channel Steamers.—The "Lynx" and the "Antelope," two of the three fine new steamers which have been built by the Great Western Railway Company expressly for the Channel Islands service, via Weymouth, began to run last Sunday. The ships are fitted with the electric light and all the most modern appliances of the ship-building art.

Edison.—It will be seen from our correspondent's report that Mr. Edison is expected in England within a few days, and that he has promised to visit the exhibition at Bingley Hall, Birmingham, on or about the 20th of August. The fame of Edison is world-wide, and there is no doubt he will receive a most hearty greeting from English electricians.

Appointments.—We are sorry to state that Mr. E. C. Rimington has completely broken down in health and has been ordered abroad. His place at the School of Telegraphy, Hanover-square, has been filled by Mr. E. T. Carter, late assistant lecturer, and Mr. E. C. Smith, of the City Guilds' College, has been appointed assistant lecturer, under Mr. W. Lant Carpenter.

Brooks' System.—We mentioned some time since that Messrs. Johnson and Phillips had become the agents of this system here, and we are gratified to learn that Mr. D. Brooks has been for some days in this country busily occupied at the Charlton Works initiating the new agents into the mysteries of the system—if, indeed, so simple a system can be said to have any mysteries.

Okonite.—The progress of electrical manufacturing in America is indicated by the increase of cable manufacturing. The Okonite Company of Parsaie, New Jersey, was established four years ago for the manufacture of cables by a new process, and occupied at first a portion only of a factory. New works have been built, and the output this year reaches the sum of half a million dollars.

Stockton.—The Electric Light and Power Corporation, Limited, and the Northern House-to-House Electricity Company, Limited, have given notice of their intention to apply to the Board of Trade for provisional orders to authorise the supply of electricity for public and private purposes within the borough of Stockton, and the town clerk will, at Friday's meeting of the Stockton Corporation, submit a report on the subject.

Australasian Telegraphy.—Some time since a deputation waited upon the South Australian Minister of Education and asked that telegraph rates to the other colonies might be reduced to 1s. for ten words. Mr. Johnson accordingly communicated with the telegraph authorities interested, and has now received replies from Queensland and New South Wales. In both cases the application for a reduction has been declined.

Wrexham.—A letter was read at the meeting of the Wrexham Town Council last week from Mr. T. Vaughan Hughes, electrical engineer to the Wrexham and District Electrical Supply Company, stating that the company was about to make an application for an order to the Board of Trade in the matter. The writer said the proposal did not mean a monopoly, but would be of great benefit to the town and district. The town clerk said there was no occasion for any resolution being passed, for the matter was only preliminary.

Blackpool Corporation.—An interesting addition to the Blackpool Corporation Gas Works is the first section of the new electric light plant for the extension of the beach lighting. An installation, consisting of a Brush Victoria dynamo, with resistances and instruments, has been placed in the exhaustor-house. It is driven from the spare exhaustor-engines, which are larger than usual and on separate beds, the speed being obtained from a counter-shaft. Two extra lamps of 6,000 c.p. are lighted on the beach, making 11 in all.

Bacup.—At the last meeting the Bacup town clerk reported as to the notice received from the Lancashire and Cheshire House-to-House Electricity Company, Limited, and the Municipal Electric Light and Power Corporation of their intention to make application for provisional orders, to be confirmed during next session of Parliament, to enable them to supply electricity for public and private purposes within the borough. The committee deemed the question one of great importance to the borough, and deferred the question to a special meeting for further consideration.

Provisional Orders Abandoned.—The Metropolitan Electric Supply Company have definitely abandoned the provisional order granted to them by the Board of Trade for the electric lighting of South London, under which they were empowered to supply with electric light the parishes

of Lambeth, Streatham, and Clapham. The North London order having been dropped before Major F. A. Marindin's enquiry, the powers which now remain vested in this company are those granted under the Mid-London and West London orders, and by their Bill of this session.

Gent and Co.'s Catalogue.—Messrs. Gent and Co., Faraday Works, Leicester, send us their new catalogue, containing a large number of illustrated descriptions of electric apparatus they supply—bells, telephones, electric light fittings, dynamos, medical apparatus, and general electrical accessories. They have also a large number of brass and china press-buttons, electric door-pulls, and contacts of various decorative designs. The progress of their catalogue, which is now in the seventh edition, seems to indicate a considerable extension in the work undertaken by this firm.

Kingston District.—A private conference of the representatives of the various local authorities in the district took place in the Kingston Town Hall last week to consider whether united action could not be taken with reference to the applications about to be made by various electric lighting companies for powers to supply the neighbourhood with the electric light. It is understood that it was resolved to oppose the applications of the companies, with a view to the local bodies obtaining powers themselves to supply the light; and the meeting was adjourned for a fortnight to decide upon what steps should be taken.

The New Brush Electrical Company.—With reference to the confirmatory general meeting of the Anglo-American Brush Electric Light Corporation, Limited, convened for Wednesday, the 7th of August, it has been found impossible in consequence of intervening holidays and other reasons to complete the formalities connected with the registration of the new company by August 7th, and as it is inadvisable to confirm the resolutions to wind up voluntarily the corporation until the new company is registered, the meeting will be adjourned until Wednesday, the 14th of August, at the offices of the corporation, at 3 p.m.

Municipal Telephones.—The use of telephones for departmental centres in towns is rapidly coming into greater favour. Coventry last week sanctioned the connection of the following places with the National Telephone Company's exchange at an annual rental of £30 for five years—namely, the house of the chief constable, the water works, the house of the captain of the fire brigade, the house of the medical officer, and the City Hospital. The Council committed themselves on these terms for a period of five years, the rental apportioned equally between the water-rate fund, water works fund, and general district fund.

Julien Cars in New York.—The equipment of the Fourth-avenue line in New York with Julien storage cars is proceeding apace. Recently, car No. 7, which has been on the line several months and having run 7,000 miles, and carried nearly 80,000 passengers, was taken off to make way for another car of newer design. The old car had not cost one dollar for repairs or alterations. There are now five new Stevenson cars on the line, and two more are being turned out by the Julien Traction Company every week. They are said to be the finest cars of the kind built, and their ease and comfort in travelling is much spoken of by passengers on the line.

Electric Waggonettes for Common Roads.—According to the *Scientific American*, which shows an illustra-

tion of the apparatus, Mr. Harvey D. Dibble, of Rapid City, Dakota, is intending to introduce electric carriages for the common roads, driven by means of overhead wires, but with simply an ordinary waggonette body fitted with motor and front steering wheel. The wires are to be on posts with overhead runners on the style familiar to us from illustrations of the usual overhead American electric railways, but there will be no rails. The proposed system may be useful in certain towns where the saving in outlay for tram line construction would lead promoters to prefer a series of electrical waggonettes to a street railway.

Electric Lighting Orders Confirmed.—The Select Committee of the House of Lords appointed to enquire into the Bills confirming the London Electric Lighting Orders, has passed the Bills confirming the whole of the orders granted by the Board of Trade, and subsequently confirmed by the House of Commons, with the exception of the Westminster order, which is still under consideration, and the South London order for the lighting of Clapham, Streatham, and St. Mary, Lambeth, which has been withdrawn. The committee also passed the Bill promoted by the Metropolitan Electric Supply Company for the supply of electricity to that portion of St. Martin-in-the-Fields which lies to the east of Northumberland-avenue, Charing Cross, and St. Martin's-lane.

Poole.—At the quarterly meeting of the Council of the borough of Poole, held on Wednesday last, the Council proceeded, in accordance with a notice to consider applications from the Anglo-American Brush Electric Light Corporation, Limited, and the Electric Construction and Maintenance Company, Limited, for the consent of the Council to applications for provisional orders authorising the supply of electricity within certain portions of the borough, and if so determined, to grant such consent accordingly. Alderman Styring did not see that there could be any objection to the Council acceding to such applications, and proposed that their consent be accordingly given. Councillor Aldridge seconded this resolution, which was agreed to.

Belfast Corporation Lighting.—The example of Bradford will doubtless be followed by other corporations. Belfast seems inclined to consider the question from the municipal control point of view, if we may judge from what the Belfast papers say: "We see no reason why powers might not be granted to the Corporation, who are the proprietors of the gas works, to erect supply stations, and distribute electricity for lighting as well as other purposes, should it be thought advisable to take such a step. Undertakings of this type should certainly be under the control of local authorities, not merely in some measure, but exclusively; and considering the amount of money spent upon the gas works, the Corporation would not be exceeding their duty were they to make the attempt to obtain the rights over any other public supply of an illuminating medium."

Electric Registering Machine.—A very ingenious invention, and one which should gain much popularity amongst the mercantile community, has just been completed by Mr. C. Jost, of the firm of Messrs. C. Jost and Co., of 16, Church Gate-street, Bombay. It is styled the "automatic self-registering machine," and has been introduced for the purpose of automatically registering goods of any kind required to be stored in or removed from ships, railway trucks, etc., so as to prevent

dishonesty on the part of persons employed in checking the delivery of such goods. By means of this machine cheating is entirely frustrated, as the number of sacks or packages removed is registered on the machine itself, and is also conveyed by a telegraphic attachment to the office of the firm on whose behalf the work is being done. It is stated that one of the leading trading companies in Bombay has already given Messrs. Jost an order for several of the new machines, and there can be but little doubt that others will soon follow their example.

Electric Railways for India.—The *Indian Engineer* publishes a note by Col. Thomason, R.E., upon the relation which the proposed electric railway is likely to have upon the future of Naini-Tal, which is no doubt a subject of very general interest in India. Col. Thomason's surveys place him in a position to prove the perfect feasibility of the proposed electric railway from an engineering point of view, whilst, on the other hand, very reliable statistics serve to give him confidence as to its financial aspect, and it should not therefore be difficult to produce a complete estimate, which should err on the safe side, and, by so doing, advance his project a very important step. The projector is, however, averse to such a course until all the pros and cons of the subject, so entirely new to India, shall have been thoroughly considered in the light of information more detailed than is at present here available, and regarding which he has for some time been in communication with experts in England. A false step at first would do much to injure the good cause of the introduction of electricity in the colony. Colonel Thomason is anxious to interest others in the project as well as himself, and writes with the view of taking into confidence those whose interests in the subject are scarcely inferior to his own, who may assist the projector by submitting valuable suggestions for the carrying out of the first electric railway in India.

Central Station for Keswick.—The statutory meeting of the Keswick Electric Light Company was held on August 1st. The provisional directors were confirmed in their appointment, with the exception of Mr. Fawcus, the engineer, who desired to be relieved of the additional duty, and his place was taken by Mr. John Birkett. The board is constituted as follows: Messrs. R. D. Marshall, J. J. Spedding, Dr. Knight, W. Wilson (Keswick Hotel), and J. Birkett. Mr. Fawcus presented a report, from which it appears that the directors have accepted the tender of Messrs. Johnson and Phillips, of Charlton, to supply all the necessary electrical machinery and instruments for the equipment of the central station at Forge, Keswick, also to supply and lay down the mains and to provide a number of transformers for the conversion of the high-tension current to low tension at the consumers' houses. The dynamos and transformers will be Kapp's patent. A turbine to drive the large alternator is being supplied by Mr. Frederic Nell, of London. To guard against the contingency of short water supply or other exceptional causes, the directors are making arrangements for the fixing of a steam engine and boiler. The contractors undertake to have the machinery in running order by the 1st of October, and it is expected the buildings will be in readiness. Messrs. Johnson and Phillips undertake to run the central station for one month after completion, at their own expense, before handing the plant over to the company, and then it has to be subject to the entire satisfaction of the company's engineers. Plans of the generating station, showing the machinery in position, were laid before the meeting.

An Improved Gas Battery.—The improved gas battery, which was shown by Mr. Ludwig Mond and Dr. Carl Langer at the recent *conversazione* of the Royal Society, is on the same principle as the well-known invention of Grove 50 years ago for the production of electricity from hydrogen and oxygen gas by the intervention of platinum. The distinguishing feature of the new battery, which has been designed to obtain large currents of electricity by means of these gases, is that the electrolyte is not employed in the free mobile state, but in a *quasi-solid* form; and it is therefore named a "dry gas battery." Each element of the battery comprises a porous diaphragm of non-conducting material, such as plaster of Paris, which is impregnated with dilute sulphuric acid. Both sides of this diaphragm are covered with the finest platinum foil, perforated with very numerous small holes, and on this is deposited a thin film of platinum black. Both these coatings are in contact with frameworks of lead and antimony, insulated from each other, which conduct the electricity to the poles of each element. A number of these elements are placed side by side, or one above another, with non-conducting frames intervening, so as to form chambers through which hydrogen gas is passed along one side of the element and air along the other. One element, with a total effective service of 120 square inches, which is covered by 1 gramme of platinum black and 0.35 gramme of platinum leaf, shows an E.M.F. of very nearly 1 volt when open, and produces a current of 2 amperes and 0.7 volt, or 1.4 watts, when the outer resistance is properly adjusted. This current is equal to nearly 50 per cent. of the total energy obtainable from the hydrogen absorbed in the battery. The E.M.F. decreases slowly, however, in consequence of the transport of the sulphuric acid from one side of the diaphragm to the other. In order to counteract this disturbing influence, the currents of gas are from time to time interchanged. The battery is said to work equally well with gases containing 30 to 40 per cent. of hydrogen—such as the water gas or generator gases produced by the action of steam or air upon incandescent coal or coke, if these gases are sufficiently purified from carbonic oxide and hydro-carbons.

Legal.—On Monday, a petition presented by the Electric Apparatus Company to continue the voluntary winding-up under the supervision of the court came before Mr. Justice North, in the Chancery Division of the High Court of Justice. Mr. Higgins, Q.C., who appeared for the company and two creditors, said the company was registered on February 23, 1884, its object being to carry on the business of wholesale and retail dealers in electrical apparatus. The nominal capital of the company was originally £12,000, but only £3,750 had been called up. The business of the company had recently become unprofitable, and in the month of July of this year, the company not being able, by reason of its liabilities, to continue business, at an extraordinary meeting, and upon due notice, a resolution was passed in the ordinary form, that the company be wound up voluntarily, Mr. Friend, the secretary of the company, being appointed liquidator. The company was indebted to its bankers and sundry trade creditors in upwards of £1,500. It was expected that the assets, independently of the goodwill, would be enough to pay all the creditors. Mr. Cozens-Hardy, Q.C., who appeared for Mr. Montague, said he did not object to a supervision order, but submitted there ought to be a reference to chambers to appoint an independent liquidator. Mr.

Montague had for some time acted as solicitor to the company, and there was a sum of £109 due to him on his bill of costs. The company was also indebted to the Edison and Swan Electric Light Company for £357 odd. Mr. Montague had made an affidavit in which he said no notice had been given to him of the intention of the company to wind up voluntarily, or to appoint Mr. Friend liquidator, until the advertisement of the petition appeared in the daily papers. The affidavit also said that it was undesirable that Mr. Friend should continue liquidator, but that a thoroughly independent person should be appointed to investigate the company's affairs. After some discussion, it was arranged that the voluntary winding-up should be continued upon the terms that if Mr. Montague's debt was not paid off within three months he was to have liberty to apply in chambers for the appointment of a new liquidator, the company undertaking not to enter into any contract for the realisation of the goodwill without giving Mr. Montague seven days' notice.

Coventry and Municipal Light.—Notice having been served by the Midland House-to-House Electricity Company, 39, Bennett's-hill, Birmingham, of their intention to apply for a provisional order for Coventry, this was considered at the last Council meeting, but, considering that the gas works have only been recently purchased by the Corporation, and that £148,000 is to be paid in 1899, the committee consider that the gas interests are entitled to the support and defence of the citizens. It is a ratepayers' question, the committee considers, and of a serious kind. The committee do not wish to be understood as fearing the result of the competition of the electric light against gas, as regards the generality of consumers in the city. Gas is, and they believe will continue to be, the cheapest. But if wealthy consumers, willing to pay for the luxury of the electric light, are lost as customers to the gas undertaking, the gas profits would be endangered, and the rates, instead of being aided, might be seriously added to. Such a risk should not be voluntarily incurred, even if the competing company were a body of citizens, and certainly ought not for a distant company, in which, probably, not a single citizen is interested. Any fresh undertaking, too, that required the breaking up of the streets from time to time, would be an inconvenience and loss. The committee, therefore, weighing all considerations, submit that the Council, as trustees of the gas undertaking for the whole city, and as representatives of the ratepayers, should, as recommended, refuse its consent to the scheme of the Midland House-to-House Electricity Company, Limited. Mr. Andrews, chairman of the committee, after explaining his views, objected to the local authorities being harassed or hurried by continued applications. New companies were sending applications everywhere, in the hope that some would be conceded, and would put towns to a good deal of annoyance in future by their experiments. He thought it better to wait. They had already made one mistake of that sort in accepting the first application that was made to lay down a tramway, and there had been incessant complaints about the state of affairs ever since. Let them not make the same mistake about the electric light, but wait till the science was more advanced than it was at present. Ald. Gulson said that in time the Council itself might ask for powers to add to its present lighting powers by supplying the electric light. The monopoly was in their hands, and to encourage a rival to that monopoly would be simply an absurdity and absolutely dishonest, because it would be

taking away from themselves the means of repaying the cost of the gas undertaking and of fulfilling the engagements into which they had entered. When the time came that the science had arrived at the pitch that it had become a necessity, then would be the time for this Council to ask for powers to add electric lighting to gas lighting and do the work then as part of their undertaking. The report was then adopted.

A Decade of Progress in Electricity.—Our American contemporary, the *Engineering News*, has an article under this heading containing paragraphs giving the following information: "This [electric] light is now coming into general use in offices, cars, and steamers for passenger transportation and for private residences, and makes the most approved light in existence to-day, in respect to convenience, quality of light, and freedom from the objections of heating and vitiation of the air of rooms, common to other methods of lighting. As an indication of the endeavours made for improved methods of lighting, it may be stated that there were 184 patents issued by the United States on electric lighting alone last year. In Massachusetts there are 69 gas companies with an aggregate capital of 12,194,000dols. The electric light companies of the State number 84, with 3,572,780dols. aggregate capital, showing that in addition to the business previously done by the gas companies the electric lighting interest has already grown to more than one quarter part the entire extent of that of the older companies. In New York State there are 92 electric light companies, with a capital of 122,445,000dols. Since the establishment of electric lighting the price of gas, which averaged for 290 cities 3.15dols. per 1,000 cubic feet in 1878, has fallen to 2dols., as determined from the average price for the same cities in 1887, a decrease of 33 per cent. in nine years. The cost of electric lighting itself has also diminished in like proportion. Carbons have fallen in price from 50dols. and 60dols. to 8dols. and 10dols. The first electric railway in the United States was put in operation at an exhibition at Chicago, in February, 1883, upon the Van Depoele system. The Daft electric locomotive, "Ampere," was run upon the Saratoga and Mount Macgregor Railroad in November, 1883. In 1886 there were in Europe 11 electric railways, and in the United States about 12, nearly all of which had been built within the previous two years. At the end of 1887 the number in operation in this country had increased to 30, and this number doubled within the next ten months. So rapidly is this development taking place that to-day there are 72 electric street railways in use, comprising over 400 miles of line and 600 motor cars. Sixty-two more are under contract for building, while it is estimated more than 1,000 cars are now being equipped with the electric motor. The West End Street Railway Company, of Boston, Mass., now the largest street railway in the world, is about to equip its entire extent of 210 miles of track with the electric power, at a cost for the whole system of about 3,000,000dols. From the experience thus far obtained on this railway, it is stated that the adoption of the electric power has effected a saving in time, on an average, of 30 per cent., as compared with horses. The longest electric road yet built, the Topeka Rapid Transit Railway, of Topeka, Kan., comprises 14 miles of line and 20 miles of track, and was opened April 3, 1889. The power plant comprises five steam-boilers, one engine of 600 and one of 300 h.p., and five Thomson-Houston generators of 80 h.p. each. Twelve cars are equipped each with two 10 h.p. motors."

PARIS EXHIBITION.—III.

SYSTEMS OF ELECTRIC SIGNALLING.

There are two systems of electric signalling in the English Section at the Paris Exhibition, both of them very carefully and practically worked out, one for the safety and certainty of railway signalling, and the other for signalling and repeating orders to the helmsman and engineer on board steamships. These are the inventions respectively of Mr. Illius A. Timmis, of 2, Great George-street, Westminster, and of Mr. J. B. Willis, that of the latter being manufactured and exhibited by Messrs. Elliott Bros., St. Martin's-lane, London.

ELECTRIC BLOCK SIGNAL SYSTEM OF MR. ILLIUS A. TIMMIS.

This exhibit is at the top of the third avenue, in the British Section, opposite the office of the engineer of the British Section. The complete system of electric block signalling for trains is shown, with two full size semaphores worked by means of long-pull electromagnets, one being for two-position signals and the other for three-position signals, illustrating both systems, both being furnished with incandescent electric signal lamps; also complete set of instruments for one signal-cabin, consisting of "Enquirer" and "Permitter," block signal instruments, and "Repeater" to indicate the movements of both the signal arm and lamps; and the necessary battery.

A thoroughly practical electric system of railway signalling may be considered far preferable to the ordinary mechanical method for the following reasons: (1) In an electric system the only work done is the actual movement of the signal-arm at the semaphore itself; whereas in a mechanical system a long train of bars and pulleys has to be shifted by the exertion of the signalman at every movement of the signal. (2) In the electric system all the intermediate parts, being mechanically inactive, can therefore be covered up or placed underground, and no repair or attention is practically required; whereas in a mechanical system the intermediate parts are moving, and are in constant need of attention and repair. (3) The movements of the signal-arm in the electric system are direct and certain, and those out of sight of the signalman can be, and are, easily repeated on an indicator in the signalman's cabin; whereas in a mechanical system the expansion of the bars, due to variations of temperature, sometimes renders it uncertain, especially in hot climates, as to whether the signal has moved properly or not. Complicated compensators are required, and indication on a repeater in the signal-cabin is not easy. (4) The difficulty with expansion makes a mechanical system not sufficiently certain to work a three-position signal as would often be desirable, and although constant attempts have been made to construct such a system mechanically, reliable three-position semaphores are not practicable from this reason; whereas in an electric system three-positions are as easy to obtain as two. (5) The electric system has the great advantage, on the score of safety, that it is impossible to place the signal-arm at "All right" or to light up the green light if it be dark until the message "Line clear" has been received by the signalman on his own block instrument from the next cabin. (6) The distant signals can be worked at any distance. (7) The point-levers can be interlocked with the signal-switches by means of a connecting rod; one half of the levers in a cabin can thus be done away with. (8) The signal-arm is mechanically locked at "Danger" so that no weight of snow could cause it to fall to "Caution" or "All right." (9) Added to this the cost of maintenance—including the charging of the secondary batteries employed to work the magnets and instruments—with all repairs, works out to not more than half the maintenance of the mechanical system, and at the same time the first cost for supply and fixing of the electric system for the same length of railway line is less than that of the ordinary system, and the signal cabins may be only half the size.

The obvious disadvantage for this or any new system is that all old railways are already fitted with other instruments and mechanical signals, and cannot at once undertake to

EXPOSITION DE PARIS.—III.

SYSTÈME DE SIGNAUX ÉLECTRIQUES.

Il y a deux systèmes de signaux électriques dans la section anglaise de l'Exposition de Paris, lesquels sont soigneusement finis, et en même temps très-pratiques, l'un sert à la sûreté et à la précision des signaux de chemins de fer, l'autre est adapté aux signaux et à la répétition des ordres donnés au timonier et au mécanicien sur les bateaux à vapeur. Ce sont respectivement les inventions de M. Illius A. Timmis, No. 2, Great George-street, Westminster, et de M. J. B. Willis, celle de ce dernier est construite et exposée par MM. Elliot Frères, St. Martin's-lane, Londres.

SYSTÈME TIMMIS DE SIGNAUX ÉLECTRIQUES ET D'INSTRUMENTS DE BLOCK DE CHEMINS DE FER.

Cet exposé est au bout de la troisième avenue, dans la section britannique, en face du bureau de l'ingénieur de la section britannique. Le système complet de signaux électriques à bloquer, est exposé, avec deux sémaphores de grandeur naturelle manœuvrés au moyen d'électro-aimants d'une course allongée, l'un s'emploie pour les signaux à deux positions, et l'autre pour les signaux à trois positions, démontrant les deux systèmes, l'un et l'autre étant pourvus de lampes électriques à incandescence pour signaux; aussi un système complet d'instruments pour un seul guérite à signal, savoir un Enquêteur, et un Permetteur, instruments de block, et un Répétiteur pour indiquer les mouvements des sémaphores et des lampes; et la pile nécessaire.

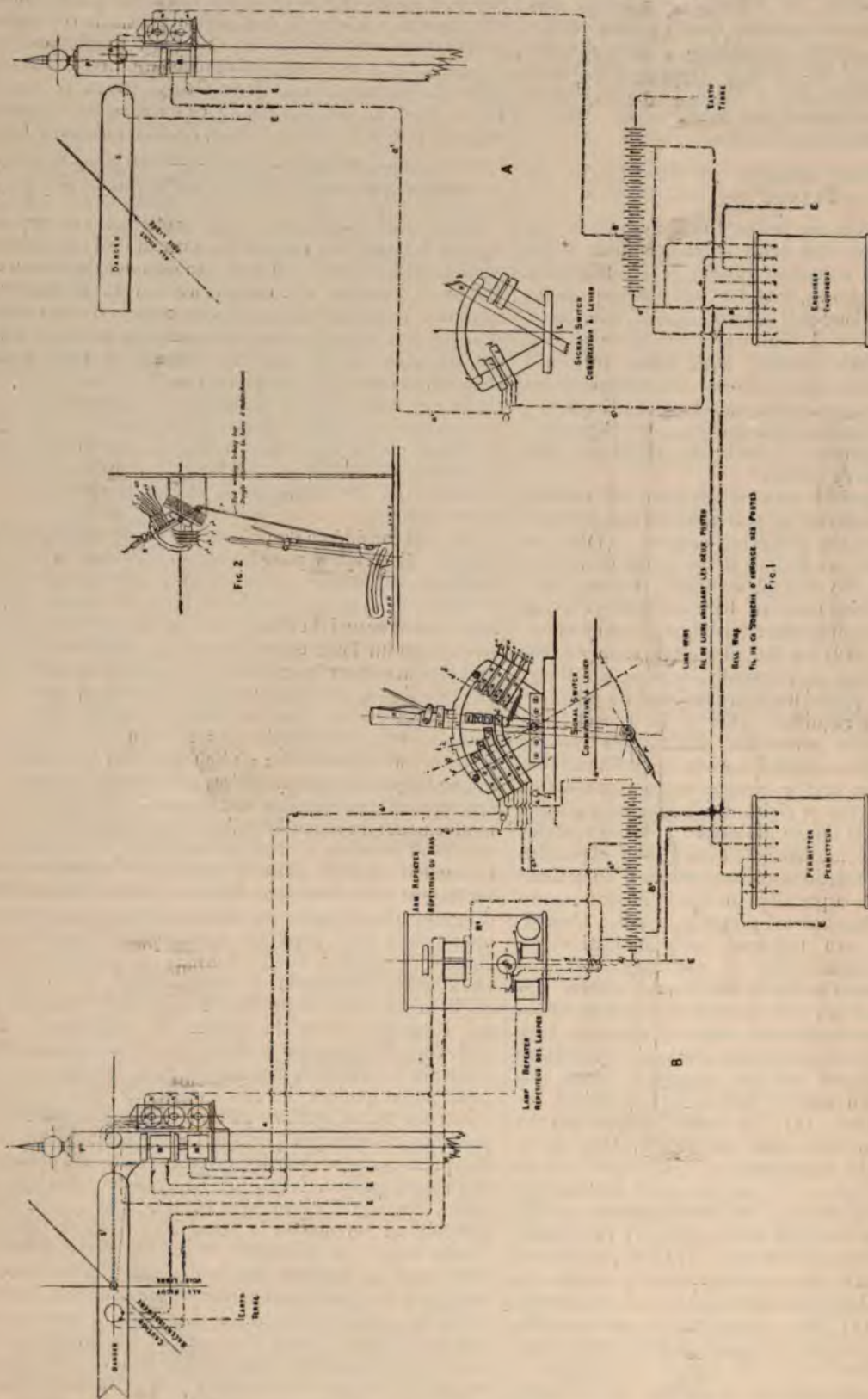
On doit considérer de préférence, un système pratique de signaux électriques pour les chemins de fer, au lieu de la méthode mécanique ordinaire pour les raisons suivantes: 1° Dans le système électrique, la seule manœuvre, est le mouvement actuel du sémaphore; tandis que dans le système mécanique un long enchaînement de tringles et de poulies doit être manœuvré par l'effort du signaleur à chaque mouvement du signal. 2° Dans le système électrique, toutes les parties intermédiaires, étant mécaniquement inactives, peuvent donc être couvertes, ou placées sous terre, et ne demandent ni attention ni réparations; au lieu que dans le système mécanique, les parties intermédiaires sont mises en mouvement et ont constamment besoin d'attention et de réparations. 3° Les mouvements du sémaphore dans le système électrique, sont directs et certains, et ceux qui sont loin du signaleur, sont facilement répétés, dans la guérite du signaleur, sur un indicateur; au lieu que dans le système mécanique, la dilatation des tringles, due aux variations de la température, quelquefois rend incertain spécialement dans les climats chauds, de savoir si le signal a mu convenablement ou non. On a besoin d'appareils de compensation, très compliqués, et il n'est pas facile de donner les indications sur un répétiteur dans la cabine du signaleur. 4° Les difficultés de dilatation rendent le système mécanique très incertain et difficile à manœuvrer pour les signaux à trois positions, et quoique des essais constants aient été faits pour construire un tel système mécanique, les sémaphores à trois positions ne sont pas pratiques pour cette raison-là; tandis qu'un système électrique à trois positions s'obtient aussi facilement qu'un à deux. 5° Le système électrique est de grand avantage à cause de sa sûreté, parce que ce n'est pas possible ni de mettre le sémaphore dans la position de "voie libre," ni d'allumer la lampe verte pendant la nuit jusqu'au moment où la dépêche "Voie libre" soit reçue par le signaleur au moyen de son propre instrument de block de la guérite d'avant. 6° Les signaux avancés peuvent être manœuvrés à toute distance. 7° Les leviers de commutateurs peuvent être enclenchés avec les leviers de signaux au moyen de tringles de connexion; de cette manière on peut se dispenser de la moitié des leviers dans la cabine. 8° Le sémaphore est enclenché mécaniquement dans la position d'arrêt, de sorte que le poids d'aucune masse de neige ne le pourrait pas abaisser. 9° Ajoutez à ceci les frais d'entretien, comprenant le chargement des piles secondaires employées pour manœuvrer les électro-aimants et les instruments, avec toutes les réparations, ne montent pas à plus de la moitié de l'entretien du système mécanique; et au même temps les premiers frais pour fournir et fixer le système électrique pour la même longueur de chemin de fer sont moindres que

alter the whole of the system. For new or contemplated lines, however, the electric system offers enormous advantages, and it is already being fitted extensively on new lines in the Argentine Republic and in the colonies.

Mr. Timmis has succeeded in making the electrical system of working railway signals practical by the introduction of his now well-known "long-pull" magnet. The

ceux du système ordinaire, et les cabines de signaleur peuvent être diminuées de moitié.

Il est évident que ce nouveau système ou tout autre est désavantageux aux vieux chemins de fer qui sont déjà fournis d'autres instruments, et signaux mécaniques, et ne peuvent pas immédiatement entreprendre de changer de tout leur système.



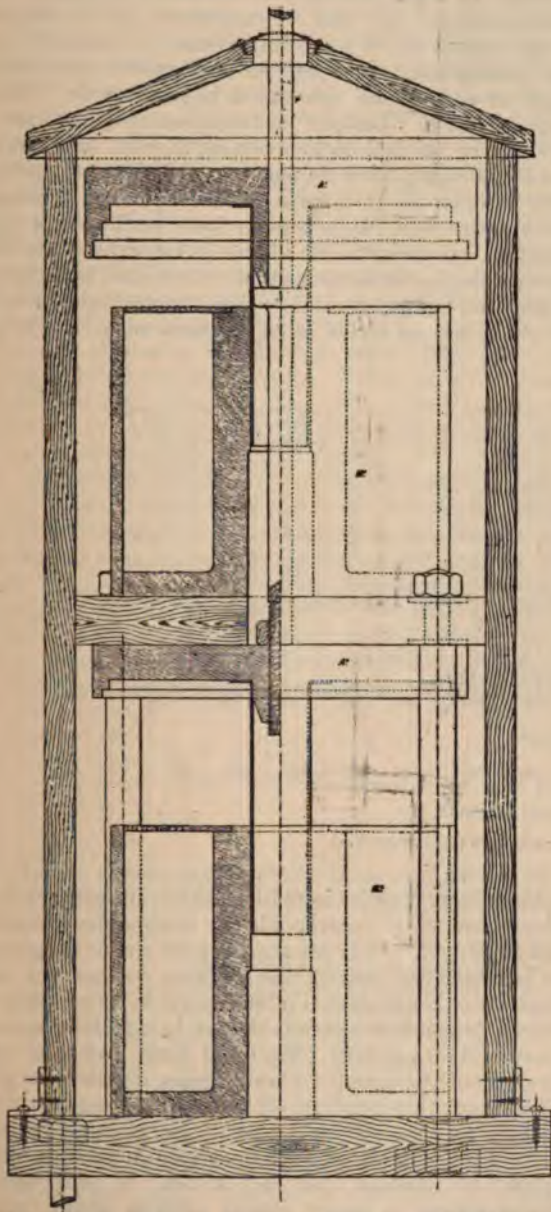
Timmis Electric Block-Signal System.
Système Timmis de Signaux Electriques de Block.

ordinary electromagnet will only exert an appreciably strong pull at the distance of a fraction of an inch, and to mechanically move the signal-arm it is necessary to have a magnet which will exert a strong force over at least a distance of two or three inches. The construction of the long-pull magnet is shown in the illustrations. It is formed in the shape of a cylinder with an inner hollow core: the edge of the outer ring forms one pole, and the inner core

Pour les lignes nouvelles ou projetées, le système électrique offre néanmoins des avantages énormes, et on le construit déjà amplement sur les lignes nouvelles de la République Argentine et dans les colonies.

M. Timmis a réussi à rendre pratique le système électrique pour manœuvrer les signaux de chemins de fer par l'introduction de son électro-aimant à course allongée, qui est déjà bien connu. L'électro-aimant ordinaire déploie

forms the other pole of the magnet, the wire being wound on the space between. The armature is of a peculiar form, like a lid, thinner at its edge than in the middle; this fits down over the outer ring and has a projecting stud of iron which enters into the hollow core of the inner pole, in the manner of a solenoid. The attraction of this inner pole upon the stud starts the action, and enables the magnet to exert a pull at the distance of $2\frac{1}{2}$ or 3 inches, which is sufficient to easily move the signal-arm. The current required for this action is five amperes, but when the signal has been moved, and has merely to be kept in position, the current is reduced by means of a suitable resistance to half an ampere. For this purpose, Mr. Timmis prefers an incandescent lamp in the signal-cabin, which thus acts as indicator as well as resistance.



Double Electro-magnet : Section. Electro-aimant Double : Section.

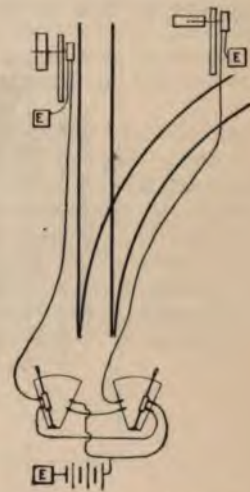
For a still longer pull, or for working the three-position semaphore, a double magnet is used, the construction of which is shown in the section. Two similar magnets are superposed, the armature of the top magnet being connected by a loose phosphor-bronze rod with the lower armature. At first the second armature is out of range, but when the top magnet is worked, it moves the signal-arm to "Caution," and pushes down the bottom armature by means of the rod to within tractive distance, where the second magnet can then exercise its effect upon the armature, and complete the pull, moving the signal-arm to "All right." The pull in pounds of the magnets is shown on the diagram, where the curve A represents the pull of the single magnet, and the curve B B the double magnet, taken from actual experiments.

The equipment for each signal-cabin consists of a sema-

une forte action appréciable seulement à la distance de quelques millimètres, et afin de faire fonctionner le sémaphore il faut avoir un électro-aimant qui déploiera une forte action sur une distance au moins de cinquante ou soixante millimètres. On peut se rendre compte de la construction de l'électro-aimant à course allongée par les figures ci-jointes. Il est construit sous forme de cylindre avec un noyau intérieur creux : le bord de l'anneau extérieur forme un pôle, et l'intérieur forme l'autre pôle de l'électro-aimant, le fil métallique est enroulé sur la partie intérieure. L'armature est d'une forme particulière, comme un couvercle, plus mince sur le bord qu'au milieu; ceci s'adapte sur le cylindre extérieur, et à un bouton de fer saillant qui entre dans le trou du noyau centrale, après la manière d'un solénoïde. L'attraction du pôle intérieur sur le bouton détermine l'action, et permet à l'électro-aimant d'exercer une force d'attraction à la distance de cinquante ou soixante millimètres, ce qui est suffisante pour faire fonctionner facilement le sémaphore. Le courant convenable pour cette action est de cinq ampères, mais quand le mouvement du sémaphore est complété, et qu'il est seulement nécessaire de le maintenir dans sa position, le courant est réduit au moyen d'une résistance convenable à un demi-ampère. Dans ce but, M. Timmis préfère une lampe à incandescence dans la cabine du signaleur, qui de cette manière agit comme indicateur et comme résistance au même temps.



Long-pull Electro-magnet.
Electro-aimant à Course Allongée.



Electrical Interlocking
Enclenchement Electrique.

Pour une force d'attraction plus forte, on peut manœuvrer les sémaphores à trois positions, on se sert d'un électro-aimant double, et dont on montre la construction dans la section. On superpose deux électro-aimants semblables, dont l'armature de l'électro-aimant supérieur est accouplée à l'armature inférieure par un tringle fou en bronze. D'abord l'armature inférieure est trop éloignée, mais lorsque l'électro-aimant supérieur fonctionne il abaisse le sémaphore à la position de ralentissement et fait descendre l'armature inférieure au moyen du tringle à portée de la force d'attraction de l'électro-aimant inférieur qui alors peut fonctionner. Nous donnons une épure des attractions des électro-aimants où la courbe A démontre l'attraction d'un électro-aimant simple, et la courbe B B d'un électro-aimant double, d'après des expériences actuelles.

L'équipement de chaque cabine de signaleur consiste d'un sémaphore, pourvu d'un électro-aimant et de deux lampes à incandescence (deux électro-aimants et trois lampes pour les signaux à trois positions), la pile, le commutateur à levier, et trois instruments de block, savoir : l'Enquêteur, le Permetteur, et le Répétiteur. Les deux premiers sont pourvus de manivelles, de contacts électriques, d'indicateurs à disque portant les mots "Voie libre" et "Ligne bloquée," pour envoyer les dépêches d'une cabine à l'autre. Le Répétiteur est pourvu d'un sémaphore miniature pour indiquer les mouvements du vrai signal, et contient aussi un commutateur, et un indicateur à disque pour allumer et pour indiquer l'état de la lumière. La pile se compose de 20 à 24 éléments secondaires de l'Electrical Power

phore, fitted with magnet and two incandescent lamps (two magnets and three lamps for a three-position signal), the battery, a signal-switch, and three instruments, the "Enquirer," the "Permitter," and the "Repeater." The first two are furnished with handles, electric contacts, and with drop indicators bearing the words "Line clear," and "Line blocked," for telegraphing between cabin and cabin. The Repeater is furnished with a miniature semaphore-arm to indicate the movements of the real signal, and also contains a switch and drop indicator to light and indicate the lamp signals. The battery consists of 20 to 24 E.P.S. secondary cells, the same battery, of course, being sufficient to work half-a-dozen or more signals from one cabin. The instruments, switches, magnets, and lamps are connected as shown on the diagram of the system.

The process of signalling is as follows:

The signalman at A sees a train coming; his line is blocked. He rings B—the cabin on the next block in front; B puts his instrument to "Line clear" (which, however, it is impossible for him to do until the previous train has passed and released his switch); B's signal drops the indicator "Line clear" on A's instrument, and at the same time makes contact, so that a current can flow to A's signal switch. A then moves his signal switch, which sends the main current into magnet, and pulls over the semaphore. On the semaphore-arm is a mercury switch, with two connections, which make contact when the signal-arms is drawn down to "Caution" or "Danger," and allows a current to flow to the Repeater, moving its arm in a

Storage Company; naturellement la même pile suffit pour faire fonctionner une demi-douzaine de signaux ou de plus, d'une seule guerite. Les instruments de block, les commutateurs, les électro-aimants, et les lampes sont mises en communication, de la manière indiquée sur le diagramme du système.

L'opération de signaler se fait de la manière suivante:

Le signaleur à A voit venir un train; sa ligne est bloquée. Il sonne à la cabine de B sur la section en avant; B met son instrument à "Voie libre" (cependant ceci est impossible jusqu'à ce que le train précédent soit passé et ait dégagé son commutateur); le signal de B fait descendre l'indicateur "Voie libre" sur l'instrument de A, et en même temps laisse passer un courant au commutateur à levier de A. Alors A fait descendre son commutateur à levier, ce qui envoie le courant principal dans l'électro-aimant, et fait fonctionner le sémaphore. Sur le sémaphore il y a un contact à mercure, avec deux connexions, qui peuvent se mettre en contact lorsque le sémaphore descend à la position de "Ralentissement" ou de "Danger" et laisse passer un courant au Répétiteur ce qui met en mouvement le petit bras convenablement au sémaphore, de façon que le signaleur peut se rendre compte de la marche du sémaphore. Comme le courant entier n'est pas nécessaire pour maintenir le signal en position, le commutateur à levier se retourne à une butée après être dégagé de la main et fait entrer dans le circuit une résistance, ou lampe à incandescence, afin de diminuer le courant. Alors le train arrive, et en touchant une pédale près de

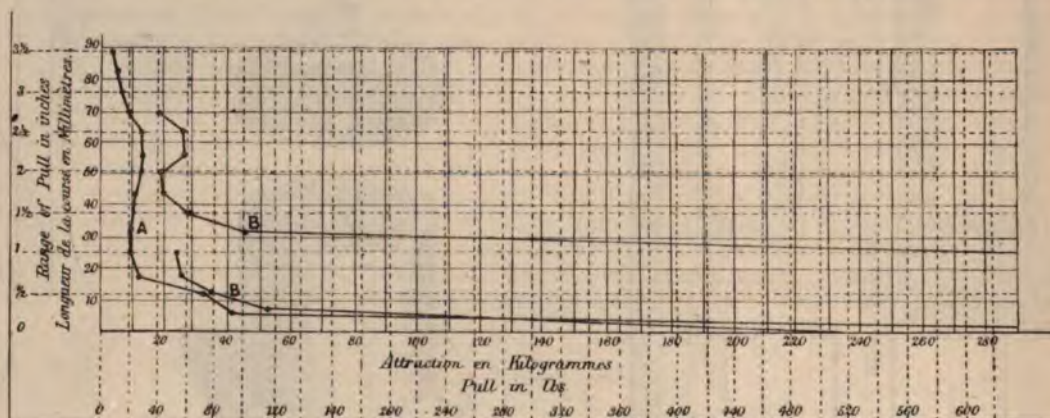


Diagram of Pull of Signal Magnets.

Epre des Attractions des Electro-aimants des Signaux.

similar way, so that the signalman A knows his signal is working correctly. As the whole current is not required to hold the signal in position, the signal-switch is so arranged as to fly back to a stop when released, and switch a resistance or electric lamp into the circuit. The train now comes by, and, touching on a pedal near the signal-box, breaks the circuit to the magnet, which is holding down the semaphore, and the counterweight on the semaphore throws the signal back to danger. This is also repeated on the "Repeater" instrument in the cabin by the mercury contacts on the semaphore-arm. The operation of breaking circuit can be arranged to be performed by the signalman himself pressing a button as the train passes if desired, as many railway companies prefer the signalman to have full control over his signals. The train is now on the line between the two cabins, A and B. A's instrument shows "line blocked," and while this remains his signal-switch can be moved about as much as he pleases, but the current is cut off, and the signals cannot now be worked until the train has passed the next cabin and B again sends a message "line clear." This connects A's switch with his battery, and all goes on as before.

The method of electrically interlocking the various signals, which are worked from the same cabin, is shown in principle on the diagram of a junction. The circuit of one signal-magnet is led through the other signal-switch, and the contacts are so arranged, as shown, that when one signal is worked it breaks the circuit of the other signal, so that no accident of allowing both signals to be down is possible.

la cabine, interrompt le circuit de l'électro-aimant, qui retient le sémaphore, et le contrepoids sur le sémaphore rejette le signal à danger. Ceci est aussi répété sur le Répétiteur, dans la cabine, au moyen des contacts de mercure, sur le sémaphore. L'opération d'interrompre le circuit peut être arrangée de manière à être faite par le signaleur lui-même au moyen d'un poussoir lorsque le train passe, si on le désire, comme beaucoup de compagnies de chemins de fer préfèrent que le signaleur ait le contrôle complet de ses signaux. Le train est maintenant sur la ligne entre les deux cabines, A et B. L'instrument de A indique "Ligne bloquée" et pendant que ceci a lieu, il peut mouvoir le commutateur à levier autant qu'il le désire, mais le courant est interrompu, et les signaux ne peuvent plus être manœuvrés jusqu'à ce que le train ait passé la cabine d'avant, et que B envoie la dépêche "Voie libre." Ceci met en communication le commutateur de A avec sa pile, et tout marche comme auparavant.

La méthode d'enclenchement électrique des différents signaux, qui se manœuvrent de la même cabine, est démontrée en principe sur le diagramme d'une jonction. Le circuit d'un signal électro-aimant est conduit à l'autre commutateur à levier et les contacts sont arrangés de manière que lorsqu'on manœuvre un signal, il interrompt le circuit de l'autre signal de sorte qu'il n'y a pas d'accident possible, en permettant deux signaux de montrer "Voie libre."

Pendant la nuit les signaux se font au moyen de lampes, le sémaphore étant pourvu d'un contact qui permet de faire passer le courant dans la lampe rouge ou la lampe verte suivant sa position. La lentille de la lanterne est colorée, et

At night the signaling is done by the lamps, the semaphore-arm having a contact to shunt the current into the red or the green lamp, according to its position. The lens of the lantern is coloured, and the advantage of the use of electric lights is a double one: firstly, the light is stronger, for the candle-power of the lamp itself is greater than the oil lamps, and has not to penetrate two thicknesses of glass; and, secondly, the trouble with cleaning and moving the heavy "spectacles" is also dispensed with. The signalman lights the lamps from his cabin by a switch in the "Repeater" instrument. The action of lighting the lamps and indicating whether they are in or out is brought about as follows: On the switch-handle is a disc, with the words "lamp in." An opening in the repeater shows usually during the daytime a drop indicator disc with the words "lamp out." At night, when the lamps are lighted, the disc "lamp in," being rigidly fastened to the switch-handle, is turned down by the movement, and comes down *behind* the disc "lamp out." Besides the contact to the lamp on the switch-handle, there is also a contact to an electric bell on the repeater. This rings for an instant as the lamp is turned on; but in the lamp circuit is a small solenoid which draws down a small iron core. This iron core is connected by a cord to the above-mentioned disc "lamp out," which it draws up from before the disc "lamp in," but ready to fall again if the current to the lamp is broken. The circuit to the bell is also made to pass through a contact on the shank of this disc, and the action of the solenoid when the lamp is lighted is, therefore, to reveal the disc "lamp in" and to break the bell circuit. If the lamp happens to go out from any cause, the disc "lamp out" falls, contact to the bell is made, and the bell rings continuously, informing the signalman that his lamp is out.

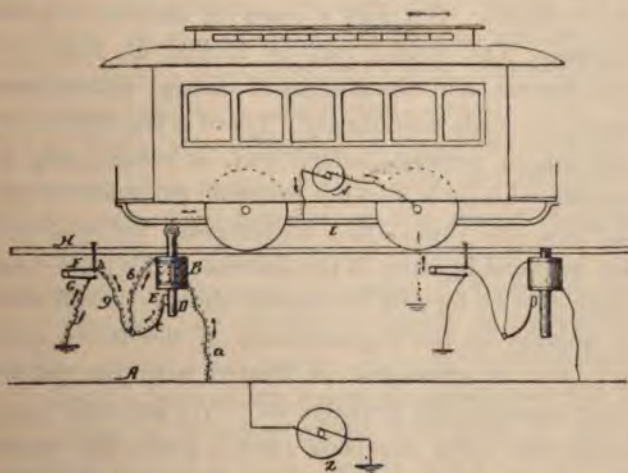
The whole system, as will be seen, is very completely and ingeniously worked out in all its details, being quick and certain in its action, thoroughly interlocked and safeguarded with indicating apparatus, and leaving little for the signalman to exercise his judgment upon, while it is easy for him to understand and manage. We understand that the system is being taken up by Messrs. Dutton and Co., signal apparatus makers, of Worcester, England, to manufacture and apply to railway working.

L'avantage de se servir de lumière électrique est double: d'abord la lumière lui-même est plus forte, car la force lumineuse de la lampe est plus grande que dans les lampes à huile, et n'a pas à pénétrer deux épaisseurs de verre; et deuxièmement l'embarras de les nettoyer, et de manœuvrer les lourds écrans à verres colorés. Le signaleur allume les lampes de sa cabine au moyen d'un commutateur dans l'instrument répéteur. L'action d'allumer les lampes et d'indiquer si elles soient éteintes ou allumées se fait de la manière suivante: sur la manivelle du commutateur il y a un disque, avec le mot "Allumée." Une ouverture dans le répéteur indique ordinairement pendant le jour un disque indicateur avec le mot "Eteinte." Pendant la nuit, lorsque les lampes sont allumées, le disque "Allumée," qui est fortement attaché à la manivelle du commutateur, est abaissé par le mouvement et descend derrière le disque "Eteinte." En outre du contact avec la lampe sur la manivelle du commutateur, il y a aussi un contact avec une sonnette électrique sur le répéteur. Celle-ci sonne dans l'instant de l'éclairage de la lampe; mais dans le circuit de la lampe il y a un petit solénoïde qui abaisse un petit noyau de fer. Ce noyau de fer est ajusté au moyen d'une corde au disque ci-dessus "Eteinte" qu'il fait monter au-dessus du disque "Allumée," mais prêt à retomber si le courant de la lampe est interrompu. On fait aussi passer le circuit de la sonnette par un contact sur la tige de ce disque, et l'action du solénoïde lorsque la lampe est allumée est par suite de montrer le disque "Allumée," et d'interrompre le circuit de la sonnette. Dans le cas où la lampe s'éteint par une cause quelconque, le disque "Eteinte" tombe, le contact avec la sonnette se fait, et la sonnette sonne constamment, et fait savoir au signaleur que sa lampe est éteinte.

Comme on le voit, le système entier est très-complet, et soigné dans tous les détails; il est prompt et certain dans son action, entièrement enclenché et sauvegardé avec un appareil indicateur, et laisse peu au signaleur sur quoi exercer son jugement; pendant que c'est facile pour lui de comprendre et d'agir. Nous avons lieu de croire que le système est en train d'être fabriqué par Messieurs Dutton et Cie., constructeurs d'appareils à signaux, de Worcester, Angleterre, afin d'être appliqué aux chemins de fer.

TRANSMISSION.

In the accompanying illustration, says the *Street Railway Journal*, is shown Blair and Blickensderfer's (Chicago) system



Blair and Blickensderfer's System for Electric Railway.

for electric railways, a recently patented method of transmitting current from a stationary generator, Z, to a car motor, N, without employing an overhead wire or conduit conductor. The motive or propelling current when passed through the car motor is a permanent current while the car is moving. Its circuit is shown by the dotted lines in the cut. Contact with the moving car, whereby the motive

current is conducted to the car motor, is made by first starting a temporary current through each helix or solenoid coil (B) as the car advances, which by the principle of "axial motion," induced by electro-magnetism, raises the moveable core D, it is claimed, till it touches the flat conductor bar placed longitudinally under the car. The initial or starting current, therefore, is temporary, and its circuit is shown by the line of dashes. The general idea of this system is to have constant contact with a buried insulated wire conductor by making a trolley or traveller out of the car itself. In operation, when each pin head H is depressed (either by the tread of the car wheel or pressure from a fifth wheel) it brings the springs F and G together at h, completing a circuit for the initial current, viz., from the main conductor wire A, through the coil B, to the return main A', (or the ground for return, as in telegraphing, etc. The initial current flows only when and while each pin-head is down; it is, therefore, but temporarily in action, its purpose being merely to first raise each forward core before the car conductor-bar leaves the rearward core "contact." But the instant the initial current flows it electro-magnetizes, and (by electro-magnetic attraction) also raises the moveable soft iron core D; and then the core, by virtue of its imparted magnetism, in turn attracts the soft iron piece E, purposely placed on the end of the spring c, and draws the spring over till in contact with the core D (at its lowest end); and that completes a circuit for the motive current, viz., from the main conductor wire A, through the core B, the spring c, core D, car conductor-bar L and motor N, etc.; back through an opposite corresponding path or duplicate mechanism.

THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence ; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices :

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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THE BEGINNING OF THE END.

It seems that the proverbial long lane is to have an ending, and the first city of the world is to be permitted to have the electric light upon a scale suited to test the value of the light in every particular. Major Marindin held his "court" and issued his report at the instance of the Board of Trade, immediately upon which a model provisional order was issued, and the business of getting parliamentary sanction was hurried on apace. On Wednesday the beginning of the end appeared, in that the Select Committee of the House of Lords, presided over by the Earl of Limerick, decided to confirm the order of the London Electric Supply Corporation for the lighting of a large part of South and West London. The preliminaries we have referred to and many others have had to be gone through before a legal status could be obtained. In these days, when everybody fights for his own hand, when it is all take and no give, doubtless it is best to have someone in authority over you, as must be the case when commercial transactions are carried out under legalised rules and regulations. But it must be acknowledged that, whilst legislation may be beneficial in some directions, commercial success will not be assured because the operation is a legal one. The success we require is a commercial one. The people who invest their money ought to be pretty certain of getting a fair rate of interest on their investment, and when they are so assured the capital necessary for fresh undertakings will soon be forthcoming.

There is one phase of electric lighting which has not, so far as we know, been adequately discussed, and it is of the greatest importance that the investing public should understand the exact position of affairs. Let us take a concrete example in order to explain more clearly. Suppose a town or district is to be lighted. The matter can be looked at from two standpoints, and the designs of central station and mains be made accordingly. There is the immediate lighting in prospect, which can, as a rule, only be partial. There is also the probable extension of the lighting, and this should contemplate the whole of the artificial lighting of the district. If a local company is to be formed, its capital should be sufficient to provide for the requirements of the latter case, and not be promoted or floated with the partial requirements only provided for. We are inclined to think that when provision only is made for immediate wants, the expenditure is always in the long run far greater than is absolutely necessary. Promoters, as a rule, do not believe in too small a capital, but we wish distinctly to separate company forming into two classes—the first where the lining the pockets of the promoters is the first and the last thought of the cute gentlemen who take the initiative ; the other the case where promoters get nothing,

the sole idea being the formation of a company for carrying out work that promises to be satisfactorily remunerative to those who invest their monies. If investors are satisfied that all is fair and square, that the company is not intended as a game of speculation on the Stock Exchange, neither a large nor a small capital will be criticised adversely. From this and similar reasoning we should prefer, as we say, to state at once the probable total ultimately required, to issue share capital to this amount, and to call up only that portion of the capital wanted for immediate payments. If a total of five hundred thousand was estimated as being required, though immediate use could only be made of fifty thousand, nothing is more easy than to call up only two shillings in the pound, the balance being called as required. We have said that work done piecemeal fashion—that is, only to provide for the exigencies of the moment—is more costly in the long run, and this should be well drummed home. A very large proportion of the expense of installation work is in connection with the mains. If these are laid with a view of the ultimate supply, the cost is out of all proportion to the returns that may be expected from the immediate supply, and yet we believe that they should be laid with the maximum rather than the minimum in view. The gas companies do not hesitate to put down mains in a new district calculated to supply the future requirements rather than the present, and they are justified by results. The taking up of mains found to be too small and the laying down of larger mains, is a hand-to-mouth business that should be avoided. The promoters of companies of a speculative character, as a rule, base their estimates upon any system that suits their purpose best, generally making the capital expenditure too small and the return too large. When, therefore, some attempt is made to do actual work the funds at command are too low to enable the management to provide for the future, and oftentimes indeed they have to starve the present. Such a system brings about disaster, as cheapness here and cheapness there means a break down as soon as the actual wear and tear of operations commence. Another and a much more difficult matter to arrange is the charge to the user. The maximum may be legalised, but this is simply a point past which a charge must not go. The great question to be solved is how much below the maximum will it be safe to go, in order in the first place to pay a dividend, and in the second place to attract customers. Needless to say, the lower the price the greater the number of customers attracted, and it may be advantageous to base the charge upon an output far in excess of that wanted at the starting of the work. Whether it is better to have a few customers at a high rate and diminish the rate as customers come on, or whether it is better to take the bull by

the horns, risk a first loss, put the price low, and obtain a greater number of customers, must be left to the directorate of individual companies to settle. There are one or two conspicuous questions upon which the technical press should be consistent and clear—at least, that portion of it not under the control of company-mongers—amongst which might be mentioned the absolute certainty that electric lighting can be satisfactorily carried out when the work is properly done; that, willy nilly, such lighting is in direct antagonism with gas interests, and nothing is to be gained by pretending the contrary; that under proper management the public may safely invest in this work with a good prospect of getting a fair, constant, and increasing return for their investment.

THE BIRMINGHAM ELECTRICAL EXHIBITION.

The Birmingham Electrical and Industrial Exhibition at Bingley Hall was opened on Thursday, the 1st inst., by Lady Randolph Churchill, in the presence of a numerous assemblage of the leading people of Birmingham. Bingley Hall is a vast enclosed space off Broad-street, Birmingham, often used for cattle shows and sometimes for exhibitions, and last year was filled with an enthusiastic mass of some 20,000 people to listen to Mr. Gladstone. This large area, though not, of course, able to compete with the combined open air and gallery exhibitions we have grown accustomed to, at South Kensington, Manchester, and Glasgow, yet contains a very large number of interesting exhibits, as well as an annexed machinery hall on one side, and a winter garden laid out for promenading and refreshments on the other side. Round the gallery of the winter garden a specimen overhead trolley line for passengers is being fixed by the United Electrical Engineering Company. This is not yet in working order; the steel cable on which the railway is to run—a kind of electrical switchback—is in place, and some of the carriages are ready, and it is expected to be in working order this week. This line will, no doubt, afford an infinite amount of amusement to the wondering multitudes, and may be expected also to do a great deal in familiarising persons with the possibilities of overhead local passenger traffic in towns in special situations, such as feeders to railway stations, and for other uses, and in special emergencies.

The intention at first broached was to have an entirely electrical exhibition, but however desirable this may have been from our point of view, the financial element had to be thought of, and it was considered better to include the local industrial department, and throw in a dash of curiosities. A good deal of the bazaar element has also found its way in as usual, but the electrical department practically comprises about half the exhibition. No attempt has been made, except in the case of the machinery, to mass or group the electrical exhibits together, and they are practically scattered all over the exhibition; but it will be found that nearly all the best-known firms and companies are exhibiting, and the result can hardly fail to give visitors a practical acquaintance with all the latest developments of the applications of electrical science. It has been remarked that at the opening a good deal was yet left to be done, but it should be stated that the original date fixed for the opening was August 15, and it was only a few weeks ago that it was decided to open on August 1, so as to include the Bank Holiday. The engineers to the Exhibition Committee are Messrs. Fowler and Lancaster, Albert Works, Birmingham, who have displayed untiring energy in laying out the exhibition and getting the machinery in order. The lighting of the hall is throughout electrical, and all the moving machinery is supplied by electric motors. Part of the lighting is done by the engineers, Messrs. Fowler and Lancaster, using the

Thomson-Houston are system, and other lighting is done by the various firms exhibiting their systems.

The idea of giving a realistic representation of a coal-mine with all the actual accessories cage, tubs, tools, etc., is a good one and has been carried out by the committee's engineers in conjunction with Mr. Foggo, engineer to the Earl of Shrewsbury, who has kindly lent the materials. The sensation of the actual descent of a mine is produced in a novel and ingenious way, first by the use of a Blackman's air propeller, which creates a strong draught upwards past the cage; and, secondly, the cage, which descends for some few feet, then comes nearly to rest, while the walls, painted as a rolling panorama, rise up and give the appearance of continued descent. The cage is actuated by a Crompton's motor, fitted with worm gearing and chain.

Another novel feature, which is one of great popularity in the exhibition, is the American shooting jungle, in which pasteboard rabbits, rats, swans and ducks, fixed on endless revolving bands, are made to run or swim this way and that as moving marks for shooting. The mechanism is worked by a $\frac{1}{2}$ h.p. Immisch motor off a 100-volt circuit running at 800 revolutions a minute with worm gearing, the bands going at 26 revolutions a minute. A large organ is fixed across the further end of the hall with a gallery, driven, of course, by a motor; and a band is in attendance and concerts are given every day, so that it is seen that the elements of a popular resort are provided.

The machinery is in a separate hall at the right hand of the main hall. The steam power is furnished by two Galloway boilers capable of working up to 300 h.p. at 100lb. of steam. The engine power comprises one Armington and Sims high-speed engine of 80 h.p. actual, by Greenwood and Batley, Leeds; a compound stationary engine of 80 h.p. actual, by Ruston, Proctor, and Co.; a compound engine of 30 h.p. by Robey and Co., and two other high-speed engines by the same firm, of their latest pattern for electric light driving, one being compound. The Anglo-American Brush Company also have a vertical Raworth engine in the main hall on their stand.

Of the lighting itself two novel exhibits are those of Mr. A. A. Goldston, of Middlesborough, who shows a Series lighting system, and Messrs. Ernest Scott and Co., Close Works, Newcastle-on-Tyne (which firm it will be remembered that Mr. W. C. Mountain, of the Gulcher Company, has lately joined), who exhibit for the first time their new type of dynamo.

Mr. Goldston has been working on the series system of distribution for some time in the North of England, and is here showing a system of combined public and private lighting on a single wire, comprising eight Brush arc lamps and dynamos, 25 Bernstein series incandescent lamps, and also 25 special series incandescent lamps of his own patented design, having a small spring cut-out inside the bulb itself, which are being made by the Edison and Swan Company for him. Series switches, cut-outs, and regulators making the complete series system are also shown. The success achieved by Mr. Goldston in the steadiness and brilliancy of the Brush arc lamps is very noticeable, and must be a cause of satisfaction to the Brush Company. It is obtained by a combination of careful adjustment of the lamps, and the electrical regulation of both engine and dynamo. A separate Robey high-speed engine, of 10 h.p., drives a Brush 15-light dynamo by means of link belting, supplied by Tullis and Co., of Glasgow. The engine is provided with Richardson's electrical governor, consisting of two solenoids acting direct upon the steam-valve, and a further magnet acts as complete cut-off in case of breakage of circuit, the centrifugal governor being done away with entirely. The ordinary Brush carbon regulator as shunt on the field-magnets is supplemented with an apparatus having a balanced magnet armature and capable of either cutting in a second reinforcing coil on the magnet of the carbon regulator, or of inserting a third coil, which is wound in opposition to the magnet-coil of the regulator and reduces its pull. A special feature of Mr. Goldston's system is his patent series switch, by which a loop in the series circuit can be cut in or out without sparking, and, at the same time, by an ingenious arrangement a solenoid cut-out is put into circuit, which short-circuits the loop should anything go

wrong in that part of the circuit without interfering with the rest of the lamps. In the series private lighting of houses, he proposes to put one of these as a main switch and cut-out in every house. The incandescent lamps used are 10-ampere lamps, and only a few volts each difference of potential.

Messrs. Ernest Scott and Co.'s dynamo has four poles disposed diamond-wise, with a disc armature running between protecting pole pieces. Although a four-pole machine, by means of cross connections it has only two brushes, and these are arranged so as to be very easily adjustable, and are at a good distance away from the armature to allow of manipulation. Scott's patent frictionless metal is used for the bearings. The machine exhibited is for 250 lamps of 16 c.p. at 65 volts. On the present circuit there are six arc lamps of 3,000 c.p. in parallel, a 5-h.p. motor and several incandescent lamps, taking altogether 130 amperes. The machine runs very steadily, and without the least sparking. A special belting by Hebblethwaite Bros., of Huddersfield, is used, made in two thicknesses, leather inside for wear, and woven cotton outside to take the strain, riveted together over the whole surface. Messrs. Ernest Scott are also showing launch engines on their separate stand, and a magnetic separator, with magnets revolving over two parallel belts, which carry forward the material after separation into two tubs or receptacles.

Besides the dynamos supplied to the exhibition engineers (which will be out of the competition for awards), Messrs. Laing, Wharton, and Down, it is understood, will run a Thomson-Houston circuit of their own. The Planet Engineering Company are showing eight of their "Alpha" arc lamps, Macquaire's patent, with electro-motor feed, which we illustrated some little while ago. The Anglo-American Brush Corporation themselves are not exhibiting Brush continuous-current lamps or dynamos in working, leaving these to Mr. Goldston, but they are showing a 35-kilowatt Mordey alternator, by which they will run alternate-current arc lamps taking 11.5 amperes each. The potential will be reduced by means of transformers from 2,000 volts to 100 in the usual way, and each lamp will be furnished with an "impedance coil," which will further reduce the potential to about 40 volts. These lamps are Brush lamps modified on the solenoids for use with alternate currents. A Victoria 400-light incandescent machine will be shown, which may possibly be run by another of the Mordey alternators working as an alternate-current motor. Messrs. Crompton and Co. have one of their usual dynamos, which drives several of the electric motors for the working machinery. Messrs. Laurence, Paris and Scott have two of their compact and well-engineered dynamos, and Messrs. Elwell-Parker are showing two of their well-known machines.

This latter firm have also two other dynamos running in connection with Messrs. Crossley Bros.' stand. Otto gas-engines, one, a 5-unit machine, with a 5 h.p. gas-engine, charges 27 Elwell-Parker accumulators used for supplying light in the refreshment-rooms, and the other, a 3-unit machine, with a 4 horse vertical Otto, drives 50 lights for Messrs. Crossley's own stand with very brilliant effect. Messrs. Elwell-Parker also show two secondary generators and a plating dynamo at their stand.

Messrs. Laurence, Paris, and Scott have also a separate stand on which they show a tiny engine and dynamo on a single base for 20 lamps of 16 c.p., also the application of motors to fans, pumps, lathes, and an 18in. circular saw, and a number of automatic magnetic cut-outs. Messrs. Crompton will show a specimen of their electric travelling crane similar to that recently described by us as at work at Messrs. Herrmann's wood yards, Limehouse, and of which several others have been ordered for various places since then. The Electrical Power Storage Company have a stand showing specimens of all their types of secondary batteries for central station work and for general lighting, for tram work, shiplighting, traction, vehicles, boats, and for surgical purposes; they also show switchboards for storage cells, with ammeters, cut-outs and bell alarms, hydrometers, and specimens of all the usual necessary apparatus for use with accumulators.

Messrs. Immisch show several types of electric motors—a 2-h.p. mining motor, a $\frac{1}{2}$ -h.p. motor driving a small

electroplating dynamo on one of the stalls, tram motor with "Crypto" variable gearing, and launch motors. Numerous photographs are also shown of the various electric launches now on the Thames; of the Sultan's dogcart, and of a new electric vehicle just made, like a three-wheeled dogcart, the front wheel for steering. The Thomson-Houston Company have a stand at which they have their arc machine for inspection. The Thomson welding machine is also there, to be shown in working, and should prove specially attractive in the town of hardware. Photographs of the Thomson-Houston overhead conductor electric railways in America give a very good idea of the progress this company has made in electric traction in that country. Messrs. Shippey Bros. show a number of C. & C. motors, and specimens of the Woodward storage battery. Some interesting historical exhibits are also promised.

One of the most striking exhibits is shown by the Edison-Swan Company, who have a very handsome stand filled and mounted with incandescent lamps of all sorts and sizes. The stand is crowned, as it were, with rows of the ordinary 16-c.p. lamps meeting in a point, surmounted in the centre by a 1,000-c.p. lamp containing two 500-c.p. filaments in parallel. Lamps of 200 and 500 c.p. are fixed at each corner, and all these are connected in circuit for lighting. The stand itself contains lamps for all purposes and of all sizes made by the company, disposed in an artistic manner and many being coloured for effect. A novelty, shown in an exhibition here, we believe, for the first time, is the focus incandescent lamp for lanterns and similar purposes, in which the filament of a 50-c.p. lamp is closely curled in a flat spiral to get a very compact and intense field of light. This form was, we believe, the idea of Dr. Fleming, and is exceedingly useful for lantern purposes. The Edison and Swan Company also show several instruments, Fleming and Gimmingham's voltmeters and ammeters of delicate adjustment, with balanced solenoids, also standard resistances, and their new "tumbler" switch.

Sir D. Salomons has a self-contained glass case in which is his automatic apparatus for electrical regulation and distribution by means of accumulators. The apparatus is for 200 to 300 lights at a pressure of 100 volts, and is similar to that he has had in use now for some years at his residence and workshops at Broomhill, Tunbridge Wells. It is arranged to render an installation with storage cells entirely automatic and self-governing, keeping the charging current constant by means of adjustable resistances, and the pressure on the lamps constant by insertion of counter E.M.F. A small motor working off the accumulators moves the contacts by means of worm gearing and belts, throwing in or out the various resistances as the current varies in charge or the pressure varies in discharge.

Of electrical fittings some good shows are made. The Acme Electric Works have numerous examples of Cockburn's cut-outs and switches. A double-pole high-tension switch with long break is here shown for the first time, and is a good piece of work; low-tension double-pole switches of solid construction are also shown, and they have a large stock of coloured and fancy glass artistically disposed. A Royce's dynamo, shown by the Acme Company, is driven from the next stand by Messrs. Dick, Kerr, and Co.'s "Griffin" gas-engine. Messrs. Fowler and Lancaster show a large variety of china fittings as applied to incandescent lighting, switches, roses, lamp sockets, wall sockets, and cut-outs; amongst the latter category Grivolat's patent, with moveable fuse blocks, is noticeable. They also show electric light brackets and artistic fittings. The Swinton-Cox-Walker magneto bell is also exhibited by Messrs. Fowler and Lancaster. Messrs. Woodhouse and Rawson have a mass of electrical fittings of various kinds, and they are showing a number of historically interesting telegraphic instruments. The General Electric Company, of London and Manchester (Binswanger and Co.), show fittings, switches, and general electrical apparatus, and make also a special point of domestic heating arrangements, coffee boilers, curling tong heaters, cigar lighters, and other applications. Messrs. Appleton, Burbey, and Williamson have a very important exhibition of their main switches for large currents. These have very well-furnished double contacts of solid slotted copper and double handles making

a most convenient main-switch for central station works. Double and single pole quick-break switches of the same type, but smaller, are equally satisfactory for ordinary work, and this exhibition of them should result in their extensive adoption.

Of electric applications to house furnishing, Mr. Julius Sax shows numerous examples: bells, calls, indicators, and burglar alarms fitted to doors and windows are a source of great interest to visitors. Electric water gauges to indicate the height of water on distant reservoirs are shown; watchmen's combined tell-tale clocks, indicators, and safety alarms for use in warehouses and factories; electric indicators for fitting in cabs and carriages, and giving directions to stop, go left, right, or speak to rider, are other interesting applications. Mr. Sax has also fitted a complete system of fire-alarms over the exhibition, and exhibits a complete system of fire-alarm bells as adopted by the Metropolitan Fire Brigade.

Messrs. Mayfield show their eight-plate Wimshurst induction machine. An extensive exhibit of miners' and domestic electric lamps with primary batteries is shown by Messrs. T. Coad and Co., of Soho-square; a speciality of the mining lamps being the arrangement of compressed air to make the electrical contact, by which, if any accident happened, the air escapes, and the circuit is broken. Special forms of faceted lenses are used to throw the light in the direction required. Messrs. John Davis and Son, Derby, also show mining apparatus, torpedo exploders, and other instruments. Exhibits of arc carbons are shown by Lacombe and Co., of Westminster, and Chas. Müller, of Bradford, who shows the carbons of Schmelzer, of Nuremberg. The latter also exhibits the ammeters and voltmeters of Schuckert, of Nuremberg. Conrad Conradty, also of Nuremberg, has a fine show of arc carbons.

A prominent exhibit is that of a Whitehead torpedo, lent by the Admiralty, who also send specimens of their field telegraph instruments and electric light fittings.

Telephone matters find two important exhibitors. The National Telephone Company have fitted up a complete central exchange in a very prettily-furnished room, with art curtains and flowers, showing the working of their system, and have provided a room where long-distance connection is made to Bradford, where visitors can listen to concerts from the town. Examples are shown of the automatic central exchange, used for half-a-dozen subscribers in outlying districts, and the coin-feed apparatus for enabling non-subscribers to ring up the telephone for 3d. or 6d., for use in public buildings, or at street corners, is also shown. The other exhibit is that of Messrs. Buller, Johnson, and Co., of Queen-street, W.C., who show a regular telephone wire collecting fixture for roofs, such as can be seen over exchanges in towns. The exhibit shows a representation of the roofs of two houses fitted with saddles, posts, braces, etc., and fitted up with a host of insulators, as would be the case in a reality, but consisting here of specimens of all the various makes of insulators which this firm manufacture.

In cables, we find a very fine exhibit by Messrs. W. T. Glover and Co., showing telegraph, telephone, and electric light cables, drums of cable as sent out in actual use, coils of flexible wire of all kinds and for all uses in electricity. Messrs. Fowler show the Tatham high insulation cable. Messrs. Henley's and Messrs. Callender are also to the front with their products in this direction.

The really ingenious, and probably very useful, electric weighing machine of Messrs. W. and T. Avery and Co. (Snelgrove's patent) finds a place here, and is an exhibit of great interest to many visitors, and there seems little doubt but that this invention bids fair for extensive introduction. Snelgrove's slow-striking electric bell is another novelty which Messrs. Avery introduce, and is one that is sure to be popular for houses and offices, instead of the ordinary vibrating or the single-stroke bells. Chemicals, especially nickel and its compounds, are shown by Messrs. Henry Wiggins and Co., of Smethwick, and Messrs. Philip Harris and Co. also show chemicals.

An extremely interesting exhibit from the historical point of view is a magneto-machine made by Messrs. Thos. Prime and Sons in 1844, since presented by them to the

Corporation of Birmingham, by whom it is now exhibited. It was constructed immediately after Faraday's celebrated experiments, and was specially visited by him. It is stated to be the first magneto machine that ever deposited gold, silver, or copper, and is the commercial forerunner of the present dynamo. For Birmingham, therefore, is claimed the honour, not only of introducing electro-plating, which prove so useful in the hardware trades, but also of the honour of first adopting Faraday's great discovery of obtaining electricity from magnetism.

One of the special features of the exhibition, as already mentioned, is the supply of power by electric motors, and many stands show processes in working order driven by this means. Messrs. Turner and Co., of Globe pointed pen fame, show the processes of pen manufacture. Mr. A. W. Abraham, of 29, Edgbaston-street, glories in being the first of his trade to apply electric power to the manufacture of briar-root and meerschaum pipes. Mr. Jos. Phillips, of Cardiff, shows the application of a C. & C. motor to glass-cutting. Messrs. W. Canning and Co., Great Hampton-street, and Mr. R. Cruikshank, Camden-street, Birmingham, drive their electro-plating dynamos. Mr. James Upton, Baskerville Printing Works, runs a printing machine by motor power, and Mr. R.

Birmingham, who were selected by the Executive Committee from amongst a number of competitors as having submitted the most tasteful novelty. The reverse side will bear the inscription "Awarded to," etc., and the inner parts will be enamelled.

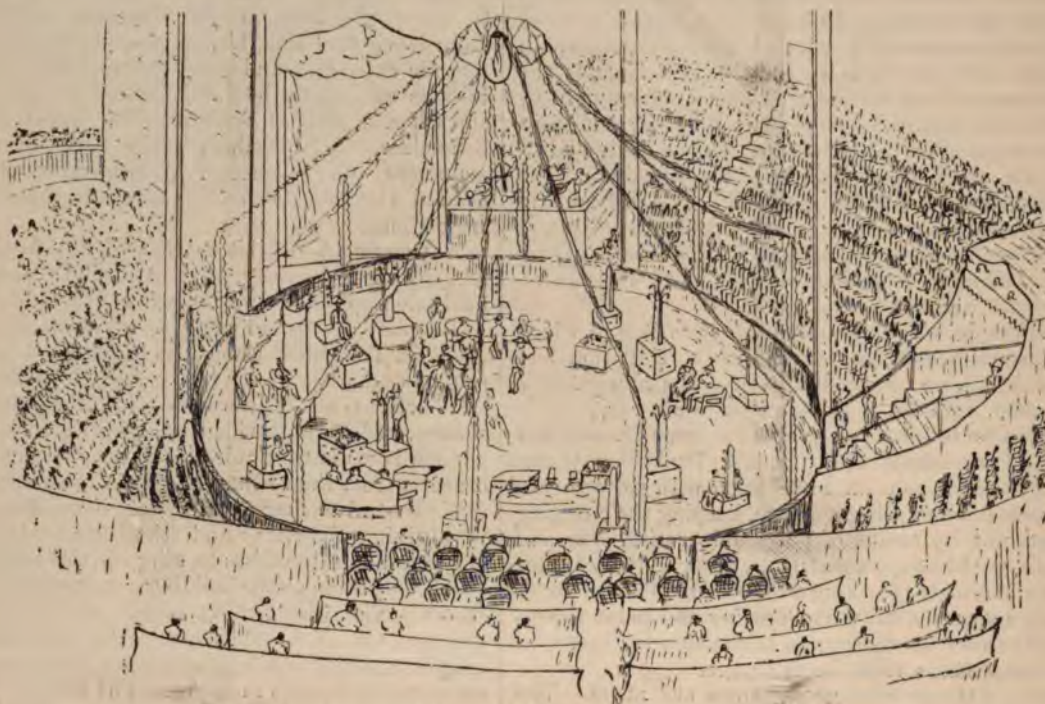
Edison is expected to visit the Birmingham Electrical Exhibition before the end of August, and preparations will doubtless be made to give him a most enthusiastic reception.

THE ELECTRIC LIGHT AT A CIRCUS.

BY S. F. WALKER.

[The season for evening indoor entertainments is rapidly coming round, and we have thought it would be interesting to many caterers to know that electricity has been satisfactorily applied to temporarily lighting so difficult a place as a circus. Mr. Walker has kindly furnished us with the following information relating to his successful work at Cardiff. ED. E. E.]

When the writer was asked to tender for lighting the pantomime at the Cardiff Circus, and was told the conditions under which the lights were to be arranged, he by no means liked the job.



Lighting a Circus.

Clarke, Vesey-street, Birmingham, has a double-action power press run in the same way. Other applications of electric driving will be made, and the ability to see these motors in actual work day after day at this exhibition cannot but be a great incentive to the far greater adoption practically of electricity as a driving power in the trades of Birmingham.



The design for medals which will be awarded at the above exhibition is given herewith. The medals will be in gold, silver, and bronze, and are from the design submitted by Messrs. Jenkin and Co., of Vittoria street,

The space in the centre of the building, which he designated by the classic name of arena, but which was styled by the circus proprietors simply the ring, was to be converted temporarily into a ballroom. Certain ornamental pedestals, flowerpots, etc., to which glow lamps were to be attached, would be carried into the ring, in the middle of the performance, and it was expected that these, carrying 80 lamps in all, should be placed, connected, and the lights burning in three minutes.

The ring was to be used for the regular equestrian, clowns, and other performances, both before and after the scene in which the electric lights were to be used, so that all wires had to be carefully placed out of the reach of both horses' hoofs and the nimble fingers of the audience.

Added to all this, it must be remembered that a circus in the metropolis of Wales does not hold the money that Drury-lane does, for instance, so that one could not have *carte blanche* to carry out the work at any cost; though, in case of mishap, no matter what the remuneration, and no matter what might have gone wrong, it would have been known that "the electric light did fail, you see." When the work came to be carried out, other difficulties cropped up.

It was decided to use a portable engine and one of Walker's No. 10 dynamos, both to be fixed in a shed in the circus-yard. The first difficulty that arose was how to get

them there, and next, how to fix them so that they would work properly. Some calculations were made with the hope of running the lights by means of a primary battery, but as it was found that at least 300 cells of not less than one gallon capacity would be required, it was decided to adhere to the other but safer plan of an engine and dynamo.

The dynamo was got in all right in parts, much amusement being caused by the surprise of the circus people at the weight of the innocent-looking parts, such as wound-magnet bars, armature on spindle, etc. The portable engine was a more serious matter, as beyond taking off the flywheel and funnel, not much could be done to lighten it. The circus was circular, or as nearly so as many corners could make it. Moreover, in building the circus, no provision had been made for dragging engines through. Eventually it was got through by all hands literally putting their shoulders to the wheel and pushing it through.

Next came the question of foundations. In Cardiff we sometimes get a good deal of rain, and it is apt to make the ground soft, not to say sloppy, hardly the kind of

wires was found to be of great service, as one would often be broken. The other ends of the flexible wires were attached to two bent springs fixed on a wooden handle made for the purpose.

On the pillars, lampholders or brackets were fixed as room allowed, and the wires supplying each pillar, which held four lamps usually, were connected to two springs inside the base of the pillar. A hole, cut for the purpose, allowed the bent springs before referred to to be pushed in so as to engage with that attached to the pillar, making a good rubbing contact. The safety of the flexible wires from the hoofs of horses untrained in electrical matters, was provided for by cutting small holes in the ring fence and hiding them there till just before they were required. The whole of the lamps were controlled by switches near the entrance to the ring; and to add to the effect they were coloured red, green, yellow, and blue alternately.

Careful tests were made before each performance of each pillar and each flexible wire. Steam was always up, and the dynamo running, with pilot lamps, some time before the scene came on, so that all that had to be done when the

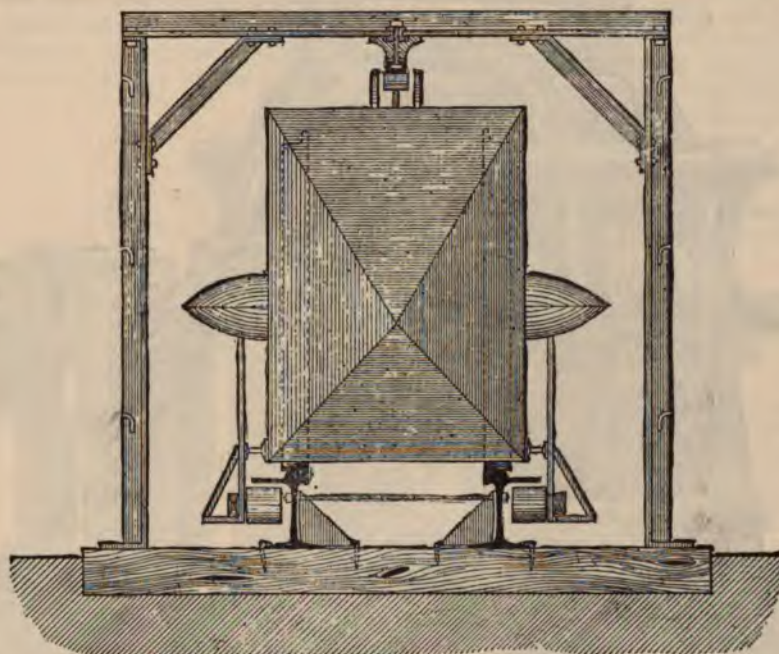


FIG. 1.—The Weems Electric System of Rapid Transportation.—End view.



FIG. 2.—The Weems Electric System of Rapid Transportation.—Train of Three Cars.

foundation for a 200-light dynamo. All these difficulties, however, were got over by perseverance. Large stakes were driven into the ground, and to these stakes solid baulks of wood were bolted, making a very fair temporary foundation for the dynamo. With the engine, once it was in place, the wheels sunk in the mud, and though it rocked a little at first no serious trouble resulted from it. Its own weight was apparently sufficient to hold it in place in the muddy ground, aided by a few wedges. Next came the difficulties of the lamps that were to go in the ring. In the centre, over all, was a 500 c.p. sunbeam lamp, that was hoisted up and down. This, of course, was a simple matter. It was attached to a corona, one of the circus properties, from which festoons of flowers depended; and the cable was led to it from the roof. There was one little matter of difficulty here, as the cable and lamp had to be kept clear of the trapezes and their ropes.

For the movable pillars, etc., the main cables were led from the entrance, round the ring, close to the top of the fence, so as to be well out of the way, and double pairs of flexible wires were attached to the cables at points opposite to where the lamps would be placed. Doubling the flexible

pillars were in place was to ring a gong as a final warning to the engineman, and then switch one group after another in first one side of the ring, then the other side, then the sunbeam, and finally the arch of lamps over the entrance.

The time of filling, starting, and running was a very anxious one indeed. It was so easy for some little matter to go wrong. The belt might slip, a brush might not be trimmed, a wire might have got broken, and possibly made contact with another, etc. Fortunately, all went well, and the sounding applause accorded by the audience at every performance during six weeks, each time the lights were turned on, was some return for the anxious time and the loss of one's well-earned Christmas holidays.

THE WEEMS ELECTRIC RAILWAY SYSTEM.

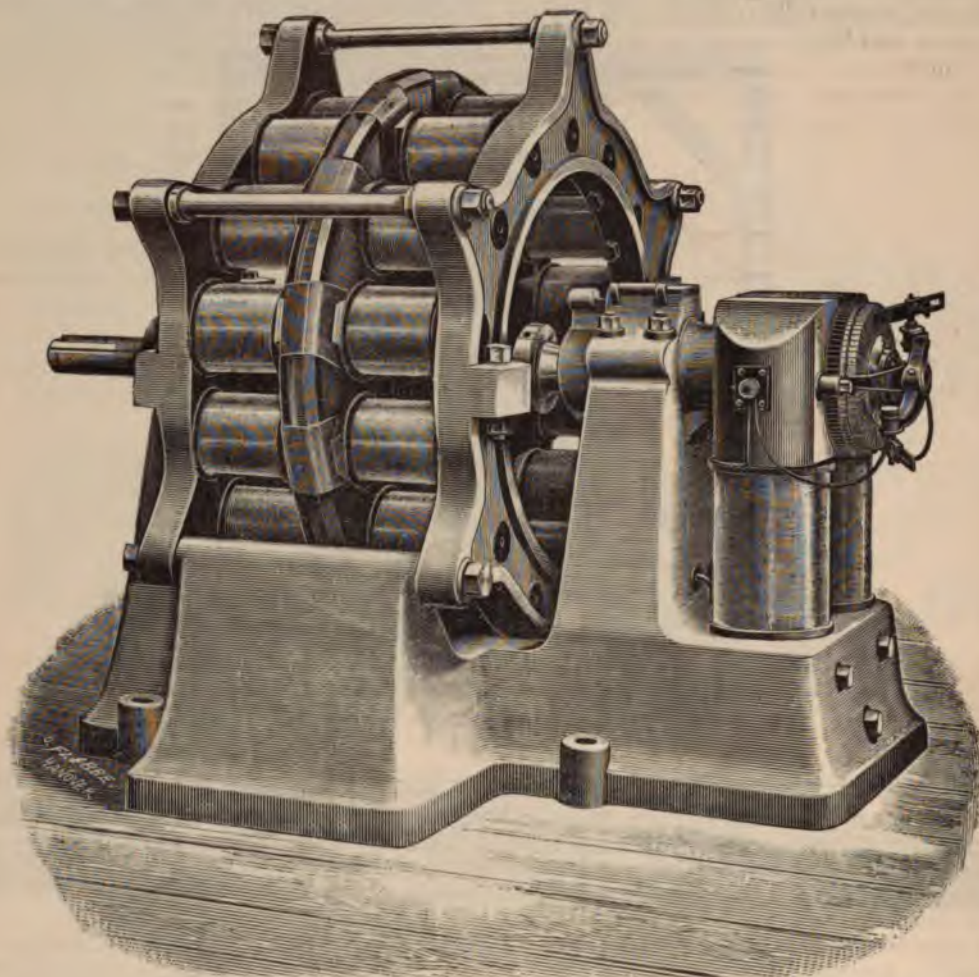
For some time past a series of experiments have been making at Laurel, Md., on an electric railway system devised by Mr. David G. Weems, the electrician of the Electro-Automatic Transit Company, of Baltimore. The experimental line erected there has a circuit two miles in

length, embracing numerous grades, some as heavy as 108ft. to the mile. Our illustration, Fig. 2, shows a train of three cars on the Weems system, placed on a road-bed, which it is proposed to enclose entirely between barbed wire fences. These wires will pass through insulated slots in the iron posts and will be employed for telegraphing and telephoning, as well as for the regular railway telegraph service. The three-car train shown consists of a motor, express, and mail car. The express, it will be seen, is "telescoped" into the other two, so as to present an unbroken exterior. The ends of the train are pointed so as to offer as little resistance as possible to the air in the passage of the train.

An end view of the train, and a section of the road bed is shown in Fig. 1. As will be noted, the journal bearings are placed outside of the car, and enclosed in elliptical housings, and the rail has an upper and lower bearing surface. A lazy wheel is carried along beneath the lower

THE KAPP ALTERNATOR.

We herewith illustrate an alternate-current dynamo designed by Mr. Kapp, and constructed by the Oerlikon Engineering Works. The machine illustrated is for a central station in Italy. Mr. Kapp has kindly furnished us with the following details, which, together with the illustration, will enable the reader to form a pretty good idea of the value of the machine. The normal speed is 600 revolutions, at which the output is 30 amperes at 2,000 volts. The armature consists of 14 coils, supported by fibre driving horns, each coil having 80 turns of wire of 120 mils. in two layers, the resistance being 1.8 ohms. The dimensions of armature core are 31in. inside diameter, 3in. wide, and 8.5in. radial depth, composed of thin iron strip. The field consists of 14 poles, with 28 magnets, 4.125in. diam., each carrying six layers of 196 mils. wire.



The Kapp Alternator.

bearing, and comes in contact with the rail only when the train rounds curves, or when there is any tendency of the car to rise on the rail.

Current is taken from a copper conductor attached to the upper framework, the current being taken off by wheel brushes.

It is proposed to control all trains from the generating station, special appliances being provided indicating to the operator the exact location of each train.

The speed attainable with the proposed system is said to be very high, three miles a minute being spoken of.—*Electrical World*.

Deaths from Shocks.—A list of causes of death by violence in New York last year was prepared by President Wilson of the Board of Health for the Board of Electrical Control. Out of a total of 1,258 deaths five were due to electric shocks, while 18 were suffocated by illuminating gas.

The field resistance is 1.76 ohms, with an exciting current of 21 amperes. It will be seen that the exciting machine is fixed on the same bedplate as the dynamo. Its armature has 304 turns of 100 mils. wire. The field-magnets are shunt-wound with 57 mils. wire, and the resistance of its field is 26.8 ohms. The exciting power at full output is 3,906 ampere-turns on each of the 28 magnets of the alternator. Energy required, 778 watts = 1.3 per cent. of output. Loss in armature, 54 volts = 2.7 per cent. Electrical efficiency of alternator $\frac{60,000}{61,858}$, or nearly 97 per cent.

Speed.	Test Exciting Current.	Volts.	Armature Current.
600	9	1,000	0
600	14.5	1,700	0
600	17	2,000	0
600	18	2,100	0
600	21	2,400	0
600	21	2,000	30

The alternator can give up to 40 amperes.

THE EDISON THREE-WIRE SYSTEM OF DISTRIBUTION.*

BY W. J. JENKS.

(Continued from page 88.)

That this increased E.M.F. does not alter the energy expanded at the dynamo is evident, for whether we consider the first case (100×1), or the second (200×0.5), we have the same result, 100 watts, about one-seventh of 1 e.h.p. for two lamps. Thus, a vast saving is effected, not only in the weight of the expensive copper conductors, but in the size of the iron tubes, the amount of insulating material needed, the weight of the boxes which join the sections, the expense of laying in the streets, and the cost of subsequent repairs.

We are now prepared to look more closely into the somewhat complex action which takes place in the three-wire system. The fundamental patent, No. 274,290, was applied for Nov. 27, 1882, and issued March 20, 1883. Figs. 3 and 3a† show the second of the patent drawings, comprising (1) a single dynamo with three brushes, the middle one at a point half way in potential between the + and -, being connected with the $\pm$ conductor, and (2) two dynamos or other sources of energy with the $\pm$ joined in the usual way.

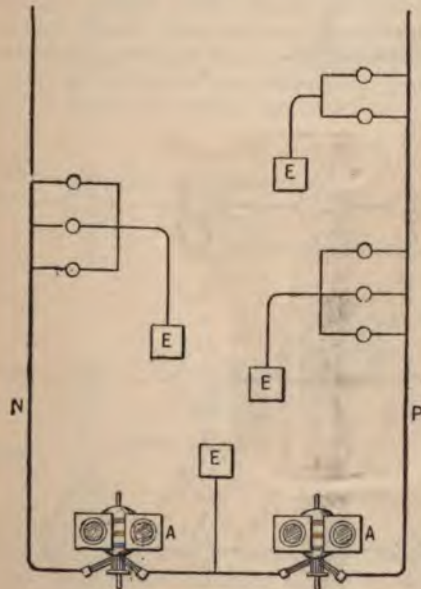


FIG. 4.

Fig. 4 illustrates a conception of grounding the compensating conductor at the station, and also making a ground at each group of lamps. Thus the current, having left the positive conductor of the system and vitalised one lamp, must make its way through two earth connections and the intervening mass before it can reach the corresponding lamp on the other side and the negative wire.

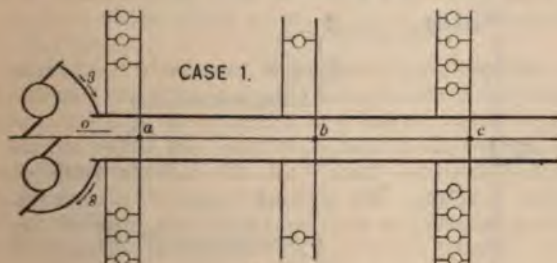


FIG. 5.

One theoretical advantage here appears. The drop of potential between the lamps or groups of a series should by this means be reduced to nothing, and no loss ought to occur between any neutral plate and the source of energy in cases where the load was not perfectly balanced. Several practical disadvantages are realised. Among them are the extreme difficulty found in actual engineering, of getting ground connections of no resistance, and of main-

* From the *Electrical World* (New York). † Figs. 3 and 3a were given in our last issue.

taining such when a number of amperes must be carried. Hence a compensating metallic conductor has always been used, though recent experiments show that permanent grounds, distributed along the mains, and connected with the compensating conductor, assist in keeping a desirable pressure by utilising the carrying capacity of the earth, and probably protect the system from the effects of lightning.

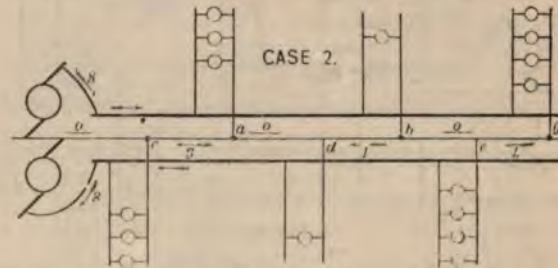


FIG. 6.

The claims of this patent include: (1) one or more compensating conductors connecting lamp circuits with the source of energy; (2) a combination of two or more dynamos, feeders, lamps in multiple series, one or more compensating conductors connecting the lamp circuits with the dynamos at the points of division; an equaliser in each feeder.

ACTION OF THE NEUTRAL CONDUCTOR.

Several conditions must be supposed with reference to this third and intermediate conductor when the three-wire system is in operation.

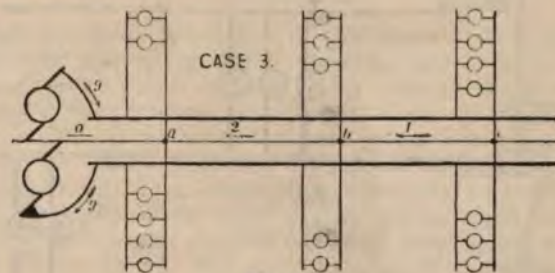


FIG. 7.

In the first case, Fig. 5, the number of groups is the same on the two sides, the number of translating devices in each group being also the same. The opposite groups are connected to the same points on the intermediate conductor, which carries no current whatever.

In the second, Fig. 6, the number of groups remaining the same on the two sides, and the number of translating devices the same in each group, the opposite groups are connected to different points on the intermediate conductor. Those portions of its length between the points of connection g and e , b and d , a and c , carry a varying number of amperes according to the number of groups represented.

In the third case, Fig. 7, the total number of translating

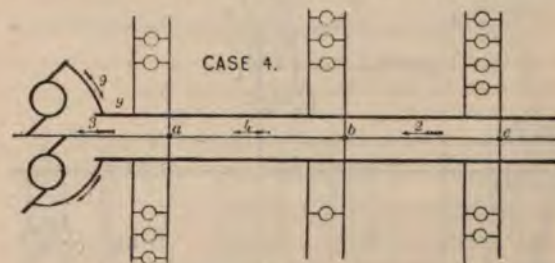


FIG. 8.

devices remaining the same, and the whole number on one side being the same as that on the other, the number in opposite groups is different, these opposite groups being connected to the same point as the third conductor. From c to b this conductor will therefore carry the current for one lamp, and b to a a second lamp in addition.

In the fourth case, Fig. 8, the number of translating devices in each group is different on the two sides, the opposite groups being connected on the same point of the intermediate conductor. Between c and b we find cur-

rent for two lamps, between *b* and *a* for four lamps, and between *a* and the dynamos for two lamps.

And in the fifth case, Fig. 9, which represents very closely the actual working of the system in practice, we have a combination of all the conditions above given. In this case, the number of translating devices in each group

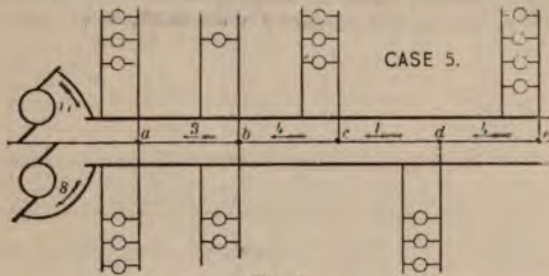


FIG. 9.

and the number of groups are both different, and the opposite groups on the two sides are connected part to the same and part to different points of the third or intermediate conductor. From *e* to *d* it conveys current for four lamps; from *d* to *c*, one lamp; from *c* to *b*, four lamps; from *b* to *a*, three lamps; and from *a* to the dynamos, three lamps.

Perhaps a still clearer conception of the subject may be obtained by illustrating graphically the analogy between electrical and hydraulic actions.

Let Fig. 10 represent a system of two pumps, one of which raises a body of water from a reservoir, A, to an elevation, B, say 10ft.; the second taking it therefrom and lifting it an additional 10ft. to a third reservoir, C. A con-

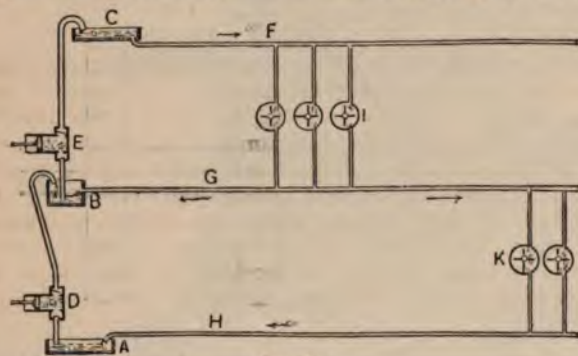


FIG. 10.

ductor, F, conveys the water from this higher elevation to three wheels, I, so arranged that portions of the water shall pass simultaneously through each wheel, all being operated by the energy due to the fall of 10ft. produced by the second pump.

Discharging into the pipe, G, a portion of the water finds its way through a second group of wheels, K, to the lowest level, H, by which it returns to the original reservoir. If the group K represent two wheels, as in this diagram, the portion of the water which has already operated the third wheel in the group I will flow along the conductor G into

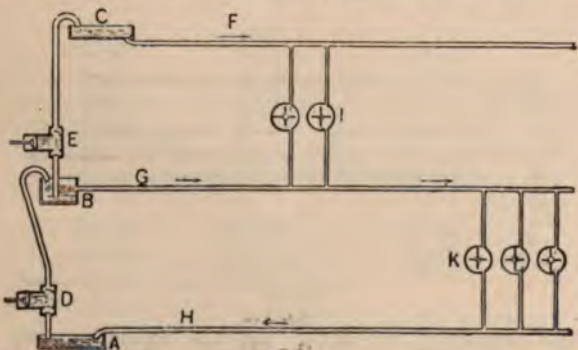


FIG. 11.

the intermediate reservoir, B, from which it is again lifted to the upper level and repeats the same action. If, on the contrary, the greater number of wheels are placed in the lower group, as in Fig. 11, the action is reversed, the lower pump, D, being called upon to do more work than the upper one, the amount of water necessary for the third wheel flowing outward from the reservoir B and returning

to the lowest level without going at all to the upper reservoir, thereby effecting a saving in power.

In Fig. 12 we have a diagram illustrating more comprehensively the ordinary working of the electrical system in practice, two groups of unequal number of devices being attached on each side, and the action being to some extent

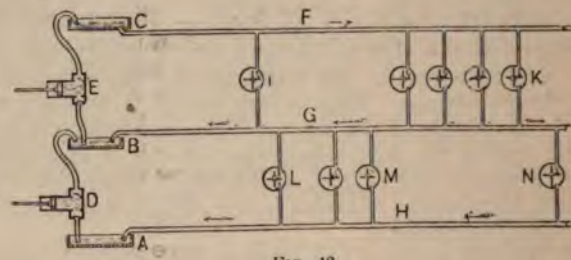


FIG. 12.

complicated, calling into use the factor of intergroup compensation by means of a middle wire, as well as that of a balancing of the sides of the system by the outlet from the upper half into the middle reservoir.

PREVIOUS ARRANGEMENTS.

It sometimes serves a useful purpose in making clear the features of a system if we describe such methods as may

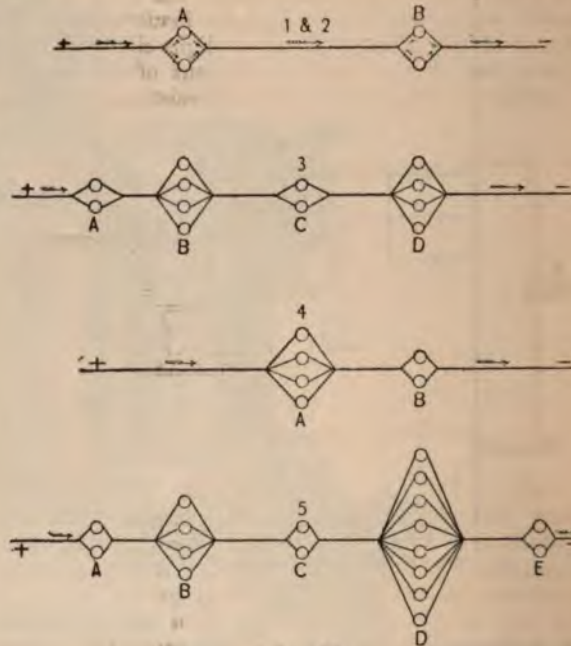


FIG. 13.

have sufficient points of similarity to make it possible to confound them with the particular arrangement under discussion.

The Edison three-wire system has been sometimes confounded in its essential features with that of the Brush

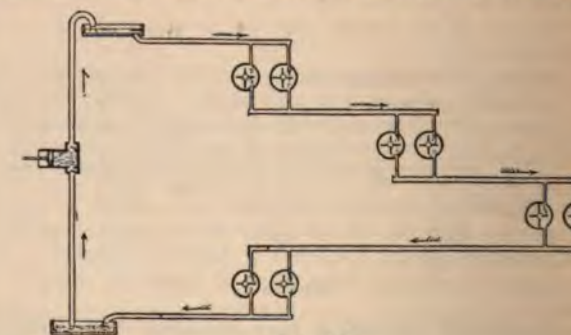


FIG. 14.

multiple series. This dividing, or subdividing a constant current, so as to place incandescent lamps on an arc circuit, was probably first proposed by Werdermann, and was patented by Mr. Brush in this country quite early in the art. Fig. 13 shows several arrangements of incandescent lamps on a Brush circuit. Nos. 1 and 2 show the electrical division where an ordinary arc current of 10 amperes is

divided between two incandescent lamps of equal power, and illustrates very clearly how the same current passes through two groups successively.

Against these on the diagram will be found two arrangements by which the same result may be effected on an Edison three-wire system. The contrast between the systems is brought out when we undertake to control lamps individually.

Suppose, for instance, in No. 5 of the diagram, we use lamps of the same candle-power and resistance throughout. In those lamps which are placed on the three-wire system we shall be able to turn any one out by the socket key without in any way affecting the brilliancy of the others, and at the same time we shall effect a saving of power, decreasing the current output of the dynamo by the exact number of amperes absorbed by this particular lamp. If, however, we undertake to do the same thing with one of the lamps on a Brush circuit we shall more or less seriously affect the candle-power and life of the others in the same group, unless in turning out we interpose a compensating resistance which absorbs the energy formerly used by the lamp, and consequently we are unable to effect economy in the running expense.

Suppose the lamps of these five groups to be of the same candle power and resistance. The amount of current which would bring the group B to a low red heat would raise either of the groups A, C, or E to a destructive white heat, and would barely warm the carbons of the group D, which would thus become invisibly hot. This constancy of the current of an arc light circuit is, therefore, in a case of this kind an element of destruction if the number of lamps, or rather the resistance interposed

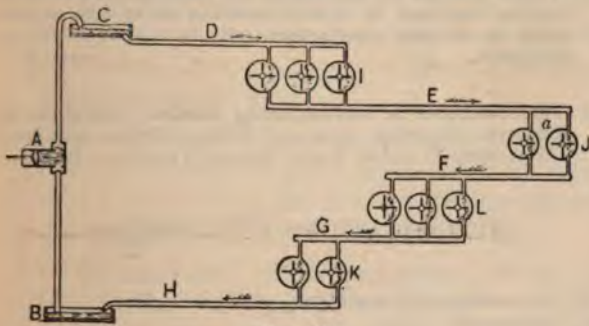


FIG. 15.

by each group of lamps, is varied. Hence, there is no compensation in this system between these groups, and no compensation without the introduction of artificial resistance between the members of the same group.

We may gain a better conception of this by another water analogue, Fig. 14. Here a single pump raises a body of water to a sufficient height to run a number of groups of wheels successively. We may suppose that a fall of 10 feet is required to operate each pair of wheels. The total elevation to which the water is lifted would, therefore, in this case be 40 feet, and each 10 feet of fall would represent a reduction in the pressure, or rather in the difference of pressure existing between the point under consideration and the level of the lowest reservoir to which the final discharge is made.

Groups of two wheels are so arranged as to correspond to groups of two lamps on a circuit using a constant current. Stopping the flow of water to any one of these wheels would either retard the entire flow, and thereby affect the working ability of others in the system, or would force a double quantity of water through the remaining wheel, thereby doubling the work done in a given time, and endangering the wheel itself.

If, now, we arrange four groups of wheels, as in Fig. 15, the wheels being of the same size and capacity, the groups of three will run slow, or else the groups of two will run too fast, precisely as in the case of the combination of two and three-lamp groups on a Brush circuit.

The contrast in the conditions of the workings of these two systems is still more noticeable when we consider the order in which they would be practically applied, Fig. 16. In the case of the Edison the group placed in each residence along a street is entirely independent of

those in any other, and each lamp is independent of other lamps in the same group, the middle wire effecting a compensation between the different buildings connected with the system, and maintaining a uniform candle-power, and compensation with the station to increase or decrease the power delivered in proportion as the number of

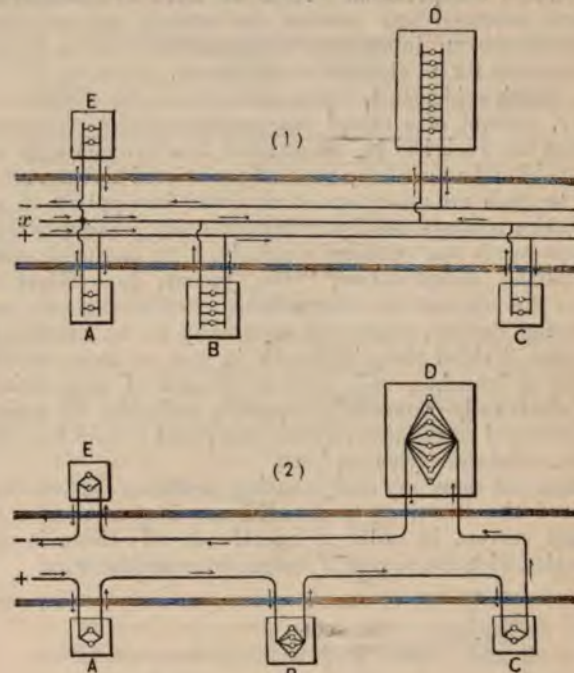


FIG. 16.

lamps is varied. In the case of the Brush system, which takes one wire up one side of the street and back on the other side, while it is possible, by varying the candle-power or the resistance of the lamps, to use up a current, say, of 10 amperes in two 5-ampere lamps, four $2\frac{1}{2}$ -ampere lamps, or eight $1\frac{1}{4}$ -ampere lamps, yet these individual lamps are not, in the strict sense, separately controllable, and practically all the variation that can be made in the number of lamps in circuit is made by turning off or on one entire group. This has the effect of decreasing or

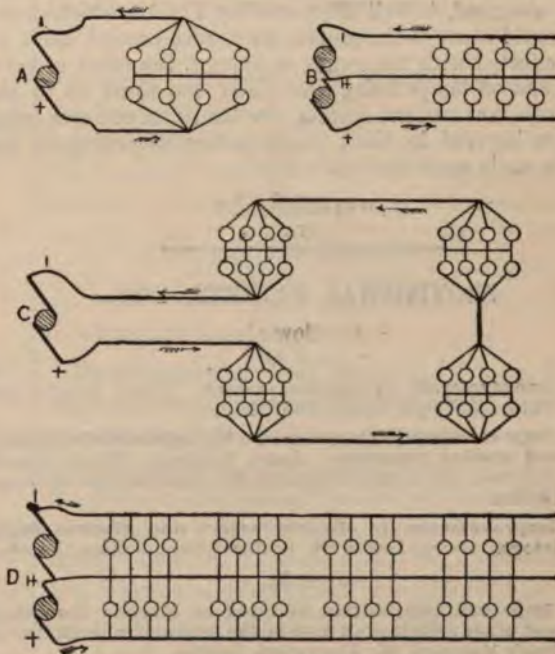


FIG. 17.

increasing the pressure at the dynamo, the current flow through the entire system remaining constant, and traversing the different groups of lamps successively instead of simultaneously, as in the Edison system.

Fig. 17 represents the closest approach to an apparent parallel on paper which can be diagrammatically made. We have at A practically two groups of four lamps each, in series, on the Brush system. At B the same number of

lamps are shown in multiple series on the Edison system. At C four times as many lamps are arranged in four clusters of two multiple series groups each, and at D the same number of lamps attached to the three-wire system, thus illustrating the effect of an extension in applying each principle. At C we have to maintain a constant current and increase the potential. At D we have to maintain a constant potential and increase the current, and we can also maintain an intergroup compensation and a total compensation for all changes in the circuit.

Mr. Brush evidently had the same idea as Mr. Edison—namely, a saving of wire and independent control—but the fact that his work had been restricted to a dynamo with a series field and an arc lamp naturally restricted his improvement to such an arrangement as could be applied to a constant-current system of varying potential. So an entirely different result was obtained—namely, high potential, and only partial compensation. His patent, No. 261,477, claims: "A system for transmitting electric currents to translating devices, consisting essentially in an electrical conductor, divided along its length in two or more series of paths or branches, each path or branch of each series being electrically connected at opposite ends with the main conductor and translating devices interposed in said branch circuits, substantially as set forth."

It does not show any compensating conductor performing either of the functions of the Edison; it must receive a constant current in order to operate at all; there is no connection with the source of energy by a middle wire.

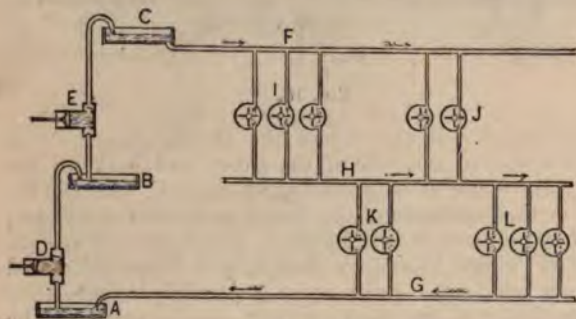


FIG. 18.

This feature of total compensation, as affecting the entire energy absorbed, is well illustrated by Fig. 18, which shows what would occur if the middle wire were carried back to and connected with the source of energy, the effect of turning on and off lamps being practically the same as in the Brush constant-current system, the lamps on one side being raised or lowered in their candle-power according to the changes made upon the other side.

(To be continued.)

PROVISIONAL PATENTS, 1889.

JULY 29.

11997. **Improvements in electric meters.** Walter Emmott and William Ackroyd, Square-road, Halifax.

12030. **Improvements in electro-magnetic apparatus for brakes and similar purposes.** James Holloway, Walter Russell Mortimer, and Arthur D'Romtra, 28, Southampton-buildings, London.

12035. **Improvements in electric meters and electric regulators.** George Forbes, 24, Southampton-buildings, London.

JULY 30.

12046. **Improved composition adapted to electric insulators and other articles and uses in the arts and manufactures.** Frank Marquard, 68, Fleet-street, London.

12047. **A mode of rendering the knobs or buttons of electric bells, electric switches, and such like, luminous in the dark.** The Hon. Francis Dudley Leigh, 68, Fleet-street, London.

12066. **An electric hand signalling lamp.** Thomas William Watson and Arthur Henry Watson, 4, Pall Mall, London.

12082. **Improvements in the arrangement and regulation of electric motors for traction, marine propulsion, and like purposes.** Alfred James Jarman, 4, Little Moorfields, London. (Complete specification.)

JULY 31.

12135. **Improvements in electric cut-outs, and apparatus for opening electric circuits.** William Edwin Heys, 70, Market-street, Manchester. (Nicholas Chaize and Jacques Chaize, France.)

12145. **Improvements in generating electricity or magnetism by the application of heat.** Philip Middleton Justice, 55 and 56, Chancery-lane, London. (Edward G. Acheson, United States.) (Complete specification.)

12161. **Electric alarm rug or mat.** James John Perkins, 32, Hanbury-street, Spitalfields.

12185. **An improved mode of distributing electricity.** Albert Harris Howard, 6, Bream's-buildings, Chancery-lane.

12188. **Improvements in apparatus for regulating and utilizing electric currents.** Henry Harris Lake, 45, Southampton-buildings, London. (Frédéric Victor Maquaire, France.)

AUGUST 1.

12236. **Improvements in appliances for the generation, distribution, measurement, and use of alternating or commutated electric currents.** James Swinburne, 49, Queen's-road, Wimbledon.

12237. **Improvements in and connected with electric transformers.** James Swinburne, 49, Queen's-road, Wimbledon.

AUGUST 2.

12251. **Improvements in electric couplers.** Ilius Augustus Timmis, 2, Great George-street, Westminster.

12270. **Improvements in apparatus for electrical sight and sound signalling on railways and in mines and coal pits.** Henry James Peddie, Tynecastle Iron Works, Gorgie-road, Edinburgh.

12286. **An electric current meter.** Sir Charles Stewart Forbes, Bart., 21, Finsbury-pavement.

12313. **Improvements in apparatus for regulating and maintaining constant or nearly constant the electro motive force in electric conductors.** Henry Lea, 7, Staple-inn, Middlesex.

AUGUST 3.

12331. **Improvements in self-adjusting electric pendulum indicators.** Frederick King and William Phillips Mendham, The Western Electrical Works, Narrow Wine-street, Bristol.

SPECIFICATIONS PUBLISHED.

1888.

12832. **Dynamo-electric machines.** Andersen. 8d.

12963. **Telephone.** Zigang. 8d.

13000A. **Making electric contacts.** Sargeant and Swete. 6d.

13208. **Electric lights.** Wells. 6d.

13221. **Mechanical telephones.** Redfern (Shaver.) 8d.

1889.

1118. **Electric switch.** Sperry. 8d.

5084. **Electric clocks.** Boulton (Pouchard). 8d.

6854. **Electrically lighting trains, &c.** Leonard. 8d.

7215. **Secondary batteries.** Askew and Pumpelly. 8d.

7992. **Combined telephony and telegraphy.** Allison (Robertson). 6d.

8456. **Portable electric safety lamps.** Bristol. 6d.

9638. **Telephone, &c., transmitters.** Drake. 6d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.	Name.	Paid.	Price Wednes- day
12 Feb. 1/2	Anglo-American Brush E.L.	—	—
12 Feb. 2/0	— fully paid ..	—	—
14 Nov. 0/4½	Con Telephone & Main ...	1	¾
27 July 10/0	India Rubber, G. P. & Tel.	10	19½d.
.....	House-to-House	4½	4½
.....	Metroptn Electric Supply	—	2½
.....	London Electric Supply ...	5	3½
.....	Swan United	3½	4½
12 July 12/0	Telegraph Construction ...	12	43¾
2 July 6/0	— 6%, 1889	100	105
29 Nov. 5/0	United Telephone	5	15½

Eastern Extension Telegraph Company, Limited.—This Company's receipts for the month of July were £42,876, as against £35,233 for the same period of 1888.

NOTES.

Electric Apparatus Company.—This company has been voluntarily wound up.

Lincoln.—Application for the introduction of electric light will be opposed at Lincoln.

Paddington.—The report upon the electric lighting at Paddington stands over until September 17.

Bradford.—The electric light is expected to be ready for supply at Bradford within about a month.

Personal.—Mr. H. A. Henderson has opened a practice as consulting electrical engineer at 20, York-chambers, Brazenose-street, Manchester.

Electric Alarm for Truro.—The electrical apparatus to call the Truro fire brigade in two seconds will cost £57, and be supplied by Mr. Perrow, of that city.

Bangor.—The consent of the City Council of Bangor has been asked for a provisional order for supply of electric light in the town, but the town clerk will make further enquiries.

Another Brush Monopoly.—According to advices from Cleveland, the Brush Company is again claiming a monopoly. This time it is for the original patent right for accumulators.

Electric Coal Cutters.—Electric coal mining machines, manufactured by the Jeffrey Manufacturing Company, of Columbus, Ohio, are now in successful operation in the Shawnee mines, Ohio.

Keswick.—Plans of the proposed buildings for the electric lighting company's machinery were submitted by Mr. J. G. Spedding, and passed at the monthly meeting of the Keswick Urban Authority.

Manchester.—At a special meeting of the Manchester City Council it has been decided that the Municipality should, following the example of Bradford, themselves apply for a provisional order to supply the electric light.

Electric Lighting Bills.—In the House of Lords the Metropolitan Electric Supply Bill was read a third time. The amendments on Electric Lighting Provisional Orders Bills Nos. 2, 3, 4, and 5 were agreed to.

Aldershot.—A committee was appointed last week to consider the application of a House-to-House Electric Lighting Company for the approval of the Local Board to the scheme for the lighting of Aldershot by electricity.

Plymouth.—At the next quarterly meeting of the Plymouth County Council a special electric lighting committee will be appointed to consider the notices of various companies for applications for provisional orders to introduce the electric light.

Chester.—A recommendation of the Watch Committee was agreed to, that application be made to the Board of Trade for a provisional order under the Electric Lighting Acts authorising the Council to supply electricity within the city of Chester, and that a special meeting be called to discuss the question.

Boston Cars.—On the Bentley-Knight electric railway at Boston, U.S., æstheticism is consulted, as usual in that fair city, and the space between and at the sides of the rails is entirely grassed over. The sensation of gliding smoothly along over a soft green lawn is decidedly a new one, with a charm of its own.

Prevention of Blacked Lamps.—Edison is credited with patenting a construction of incandescent lamp, by which the transfer of particles of carbon from the filament to the glass will be prevented. This consists in coating the interior of the globe with a thin, transparent, adhesive and semi-liquid conducting film.

Electricity on Railways.—The use of electricity for subsidiary purposes is constantly extending on American railways, and we recently mentioned the use of electric motors for an engine turn-table or transfer-table. The Fitchburg Railway Company have contracted with the Westinghouse Electric Company for an electric plant to work another of these tables, and also run 200 incandescent lights at its waggon works.

Wrexham.—At a meeting of the Denbighshire County Council the clerk read a letter from Mr. T. Vaughan Hughes, electrical engineer, Chester, on behalf of the Wrexham and District Electric Supply Company, requesting the Council favourably to consider an application to the Board of Trade for a provisional order by which electricity can be supplied within the area of the hundred of Bromfield. No order was made.

Electric Railway Convention.—The association of electric railway men, recently alluded to, has now been thoroughly organised, and a meeting will be held at Minneapolis on September 14th, when a number of papers on practical subjects will be read. It is confidently expected that the association will spread all over the country, and be able to act in union with reference to legislation upon the subject of electric street railway.

Dublin.—At the usual monthly meeting of the Dublin Corporation, a report was read a first time from the Special Electric Light Committee recommending that application be made for sanction to the borrowing of £50,000 to carry out a scheme of electric lighting for public and private purposes in the city, and also to empower the committee to acquire forthwith a suitable site for the erection of the necessary plant.

County Council and Electric Light.—The Paddington Vestry has written to the Board of Trade a letter, in which it is observed: "The vestry is glad to learn that the Board of Trade agrees with the vestry that the proposed transfer of control from the local authorities to the County Council cannot properly be introduced into a provisional order, and that those who think it desirable must bring the matter before Parliament, the proposed change involving an alteration in the law."

Bournemouth.—At a meeting of the Bournemouth Improvement Commissioners, the clerk produced notices of intention of the following companies to apply for a provisional order to enable them to supply electricity within the district: Anglo-American Brush Electric Light Corporation, Limited; the South of England House-to-House Electricity Company, Limited; and the Electric Construction and Maintenance Company, Limited. It was resolved that the Lighting Committee be requested to collect information and report on the matter.

Municipal Station for Ayr.—Ayr Town Council intend to apply to the Board of Trade for a provisional order to enable them, if so decided, to light the streets and town buildings by electricity. A number of the councillors have been inspecting the electric lighting station of Messrs. Muir, Mayor, and Coulson, Glasgow, and the inspection has, it is understood given satisfaction. The water of the

dam at Ayr mills might, it is thought, supply the motive power for the dynamos. A report will be submitted by the Council before any steps are taken in the matter.

Hereford.—At the quarterly meeting of the Hereford Town Council, two notices of application for provisional orders were considered, and a letter was read from the town clerk pointing out that as the gas works were owned by the town, and that no immediate demand for electric light had been shown, it would be better either to apply for an order themselves or to oppose it. As the Board of Trade would hardly allow them to carry through a provisional order themselves unless they intended to carry it out and provide facilities, he thought it would be better for the Council to oppose the orders.

A Gas Manager on Electricity.—On Thursday, the 25th ult., Mr. Geo. Lane, manager of the Aylesbury Gas Works, delivered the first of a series of lectures on magnetism and electricity to the boys at the High School, South Hackney, London. The principal, Mr. W. F. G. Foat, presided. The lecture was illustrated by numerous experiments, and was highly appreciated by the boys, who passed a hearty vote of thanks to Mr. Lane. It is a sign of the times when gas managers take to lecturing on electricity. May we expect developments in electric lighting at Aylesbury before very long?

Projected Tramway Work.—It will be important for electrical engineers engaged in traction work to notice a new regulation which in all probability will shortly be adopted on the London County Council. With the object of keeping the County Council informed of projected tramway or railway works within the county of London, Mr. Courtney has drafted a new standing order which requires that where the proposed work or any part of it is situated within the county, a copy of the plans and sections shall on or before the 30th day of November be deposited at the office of the London County Council.

The Brush Company's Meeting.—A formal meeting of the Anglo-American Brush Corporation took place on Wednesday in order to adjourn the actual meeting of winding up and transfer to the new company to a later date. We understand that some differences of opinion were expressed by Mr. Lane-Fox as to claims which he has upon the old company, and the proposals which he has submitted to the company in settlement of such differences have been deferred to arbitration, Mr. Slade, Mr. Drake, and Mr. Gorham having been appointed to carry out the negotiations on his behalf with the Brush Company.

Electric Surgery.—Sir William Dalby, M.B., read a paper at the meeting of the British Medical Association, at Leeds, on Wednesday, upon his surgical treatment of the ear in aural exostoses. He said he found the use of the electric drill lessened the time required for the performance of the operation, and that 2,500 revolutions per minute was the limit of speed. The use of force under these circumstances being unnecessary, and there being less hemorrhage because of the heat, another advantage was that there was no tendency in the drill to project into the cavity after the growth had been penetrated.

Bangor.—The Bangor City Council have received a circular from the Board of Trade stating that the Midland House-to-House Electric Lighting Company, Limited, had intimated their intention of applying for a provisional order to enable them to supply Bangor, amongst other towns, with electric light, and asking for the Council's consent in the matter. The Water and Gas Committee, on

the advice of the town clerk, resolved to take no notice of the question in its present stage. The town clerk, who would be in London, stated that he would call at the Board of Trade offices and make enquiries on the matter.

Incandescent Lamp Patents.—The following cablegram has been addressed to the National Company for the Distribution of Electricity by Secondary Generators, Limited, 18, Warwick-street, Regent-street, (J. E. Pickering, secretary,) by Mr. George Westinghouse, jun., Pittsburgh, U.S., dated August 12th: "Decision yesterday, Judge Wallace in United States Court in case conducted by Edison Company, construing Supreme Court decision, holds American patent expires with prior patent abroad, even when void for failure to work or pay taxes. This decision overthrows high resistance carbon filament patent, main reliance of Edison Company for maintaining monopoly incandescent lighting in United States."

Feeders to Railway Stations.—The telfer line to Alexandra Palace from Wood Green station on the Great Northern is the first of what may be eventually a very extensive system of electric feeders to the main railways. In many cases, in the suburbs where it will not pay to extend the branches of the railway lines, there are yet tracts which will require opening out for residence, or, in the country, towns or villages, at some little distance from the railway station itself. For these in many cases electric tramway feeder lines would prove the solution, and be both easy and profitable in attainment. Where the electric lines are feeders in conjunction with a railway, they would in some circumstances be undertaken by the railway companies themselves, but even if not, there would not be great difficulty in arranging easy methods of changing trains, and tickets could be booked through and cleared in the ordinary way.

New York Exhibition of 1892.—Paris is great, but New York is to be greater. This is the idea of the wonderful exhibition which it is now practically settled will be held in New York in 1892. The great feature is to be the extensive adoption of electric motors, and it is proposed that the whole of the moving machinery should be electric. Money might even be saved in this way by the doing away with engines, shaftings, and belts, for 10,000 h.p. could be brought into New York from distant waterfalls at 10,000 volts, reduced at the confines of the exhibition to 1,000 volts. This argues the perfection of the alternate-current motor, which, it may be hoped, will be the triumph of science at the proposed exhibition, but continuous-current motor converters might be used, and the demonstration on an immense scale such as this of the entire feasibility of power transmission would indeed be a gigantic success of world-wide interest and utility.

Separation of Mercury from Copper.—Messrs. Smith and Frankel have described an electrolytic method of separating mercury from copper, of which the following abstract is taken from the Chemical Society's *Journal*: "Mercury can be completely separated from a solution containing a large excess of alkaline cyanide by using a comparatively feeble current (evolving 0.2 c.c. of water gas per minute). The deposit is grey, and is best washed with water. Copper, under similar conditions, does not deposit until all the alkaline cyanide is decomposed. Attempts to separate mercury from copper by this method resulted, in some cases, in the deposition of small quantities of copper along with the mercury, whilst in others the mercury was not entirely deposited. The errors varied from +0.05 to -0.98 per cent. of the mercury taken. The results were

unsatisfactory when the copper exceeded 20 per cent. of the mercury. Silver and copper cannot be separated by the above method."

Alternate-Current Motors.—It is stated that the Westinghouse Electric Company, having completed the details of their alternate-current motor, are now arranging for its introduction on a large scale, both for stationary and for railroad work. On account of the fact that no sparking is possible with these motors by reason of the entire absence of commutators, the mines where gases accumulate are adopting them with much success. This, by the way, is the exact opposite of what we believe has been found with the Ganz motors, the great difficulty being the blinding flashes that took place at some part of the motor when it was getting into phase. However, alternate-current motors seem to be shaping somewhat towards practical utility, and we may soon hope to be able to judge of them by actualities. What with the development of these, and new discoveries reported in the shape of alternate currents generated direct from heat (or, what comes to the same thing, increased or doubled by the application of heat) the alternate-current electrical engineer's millenium may almost be considered within practical distance.

Tender for Mauritius.—The Municipality of Port Louis, Island of Mauritius, are inviting tenders for lighting the city of Port Louis by gas or electricity. Sealed tenders, in duplicate, will be received by the Municipality until the arrival at Mauritius of the mail which leaves Marseilles on 1st October, 1889, from all persons who are prepared to undertake the lighting of the city by gas or electricity, in accordance with the clauses and conditions stipulated in the specification deposited at the secretariat of the town, and of which a copy, certified by the secretary of the city, is deposited at the National Provincial Bank of England, 112, Bishopsgate-street, London; and with M. L. G. Adam, agent-general for the Corporation of Port Louis, 134, Boulevard Haussman, Paris. Tenders should be made in the form to be supplied at the same addresses, and if made by persons situated outside the colony should be sent at least 15 days previous to the departure of the above-mentioned mail to the addresses given, with a note, not sealed, giving the name and address of the person tendering and his sureties. The decision will be given in the month succeeding the arrival of the mail at Mauritius.

Merry and Wise.—It is well known that we deprecate any discussion or fine hair-splitting on the subject of units, but on this subject an American contemporary, the *Electro Mechanic*, eminently "takes the cake." Under the heading of "Electrical Information, collected by Amber," we find that "the Ohm is named after a Prof. Ohm who invented it." To hear about "a Prof. Ohm" is delicious; but the volt—the volt's the thing. "A volt is the standard or unit of electromotive force. European electricians call it an 'element.' It is the parts of which an electric battery is constructed, and consists of plates of zinc, copper or prepared carbon, which are immersed in a liquid containing one of a limited number of acids employed for the purpose of generating electricity by contact with the metal or carbon. A battery consists of a number of volts, the number varying with the strength of the electric current to be generated. The term 'volt' is formed from the same as Volta, the Italian scientist, whose name is prominently connected with the development of electric science." Really, a paper having any pretensions to

instruct the public upon technical points should keep a contributor of the nature of "Amber" under some restraint.

The Poet's View of the Dynamo as an Executioner.—The execution question continues amain in the States: Edison has had his say, sundry witnesses have proved that unintentional experimenters have received shocks, and experienced untold agony. One man brought a dog—the hero of the hour—who was shocked, left for hours as dead, and yet walketh. Mr. Harold P. Brown acknowledged he favoured the electrical execution "principally because Edison did." Lawyer Cockran has been strenuous in his endeavours to discredit the whole affair, and the poet of the New York *Electrical Review* (F. C. Schneider) breaks out as follows:

How doth the little dynamo
Improve its spinning coil,
By gathering volts and amperes up,
The murderer's head to spoil!
How merrily it seems to sing!
How bright its glittering spark!
Its joyous note is like a knell
To him whose ways are dark.
How quickly turns its armature,
Revolving in the "field,"
The murderer's lot's a hapless one
'Less Cockran him can shield.

Colliery Fittings.—Messrs. John Davis and Son, All Saints' Works, Derby, send us their catalogue of electric apparatus, which they supply and fit up for ordinary lighting, and also for special application to mines. Messrs. Davis do not appear to manufacture their dynamos, and have taken agencies for the Brush, Victoria, and Castle dynamos, which with other apparatus they illustrate in their catalogue; but in colliery fittings they manufacture specialties of their own which they have given considerable attention to, in order to produce a thoroughly strong damp and dust proof fitting for incandescent lamps for outdoor and colliery use. These are made so that the lamp is protected by a strong glass cover, and arranged so that any ordinary labourer can clean the fitting without touching the connections, and they appear to be at a very reasonable price. These fittings have been introduced largely for colliery use, and the model coal mine at the Birmingham Exhibition is supplied with these special fittings. Messrs. Davis also manufacture electric fittings suitable for illuminating shop windows from the outside, to replace the ordinary gasfittings. Special attention is given to electric mine exploders and all other necessities for use in colliery work, in which Messrs. Davis are also largely engaged in other directions.

St. James's.—Applications have been received from three companies—the London Electric Supply Corporation, the House-to-House Electric Light Supply Company, and the Westminster Electric Supply Corporation. As the first-mentioned company are already supplying electric light in the parish of St. James's, although outside the provisions of the Act, the Vestry have decided not to offer any opposition to the granting of a provisional order to them, subject to certain conditions, as the withdrawal of that company might cause at least a temporary inconvenience to such of the parishioners as are drawing their supply of light from them. These conditions not being accepted, the Vestry will object to an order being granted to the company. As regards the applications from the other companies, in view of the small area of the parish, the loss and annoyance that would result from the

unnecessary frequent disturbance of the streets arising from an unduly large number of companies at work in the same area, the probability of an increased charge for the light that would be caused by an excessive expenditure of capital in duplicating mains unnecessarily, and the precautions adopted for securing competition, the Vestry have decided not to assent to the introduction of any further general installations into the parish at present.

Six times the Profit and Less Expenses.—The electric railway at Des Moines, Iowa, seems to have been an immense success, judging from the account by a correspondent of the *New York Electrical Review*. There was a horse-car road, finely equipped with new cars and fine horses, but the people would not ride. They preferred to walk rather than drag along at a slow pace over the heavy grades in the city. The road did not pay expenses. The system was changed to the Thomson-Houston electric system, and cars are now running on a track nearly five miles in length, with several branches, loaded to their full capacity, making six or eight miles an hour, up and down 10 per cent. grades, without overheating the journals or sweating the conductor. On one of the branches the other day there were nearly one hundred people on a car, the only connection between it and the power-house three miles distant being a number two copper wire up in the air. The car with that load ran six miles an hour up 10 per cent. grades, stopping and starting at any required point. The company have never had a dollar of repair to make on the road—none have been needed. The cars are always crowded, and the stock which was on the market at 25 cents on the dollar a short time ago is now hard to find at 150. The road is paying eight per cent. on 400,000dols., and the operating expenses are actually less than for horse car lines.

Brymbo.—The town of Brymbo, near Wrexham, wants light. The gas company cannot supply them without the formation of a new company, and they think they might just as well have electric light under these circumstances. Mr. Vaughan Hughes, Chester, entered into some particulars as to the production of electric light to a meeting called to consider the question, and gave some prices. Twenty lights, of 8 c.p., in a room for a quarter would be about £5. 14s. 9d., and a cottage with five lights would be £1. 8s. 8½d. per quarter. The electric light could be used in churning, pumping, mangling, turning a sewing-machine, etc., which would be a great boon. A room 30yds. long, and 30ft. wide, would require four lights of 500 c.p. Mr. Bernard Lewis said he had seen Mr. J. H. Darby, who told him he would do his best to promote electric light into the district. The new Electric Syndicate had given notice to the Town Council and County Council that they had got the power to bring electric light to this neighbourhood. Mr. V. Hughes said it would take about three months to get the electric plant into working order. Mr. T. Charles said he was very anxious to hear Mr. Darby. He had approved of the electric scheme, and they should open their arms to receive the company in carrying out the scheme. Mr. J. H. Darby then proposed that the neighbourhood be canvassed, to see whether they would take gas or electric light at an equal cost. This was carried, and the meeting was eventually adjourned to receive the result of the canvassing of the neighbourhood.

How They Look at It.—At the half-yearly meeting of the Gas Light and Coke Company, held last Friday, the chairman, Colonel Makins, M.P., acknowledged that this year the attention of the directors had been given to the

question of electric lighting, but, he said, "the directors viewed the threatened competition of the electric light companies with no alarm whatever. London at the present day contained upwards of 550,000 houses, more than half of which were still unsupplied with gas, and were to a great extent situated in such localities as were unlikely ever to become attractive to the promoters of more costly illuminants. The company's increase of business, specially in regard to the use of stoves, was very satisfactory, and, as far as the board could judge, had not been at all adversely influenced by the electric light, in which he admitted there had also been a small increase. The increase so far in electric light was a mere bagatelle, but whether it was large or small, it would not prejudicially affect the company's existing business. In all the new systems of illumination there were generally certain drawbacks to be overcome, which would prevent anything like rapid progress for a good many years." The point of these remarks, however, is that the reduction the directors felt it necessary to make to combat the introduction of electric light, has cost them £104,000; and that in congratulating themselves on the increase of gas stoves, the company are proving timely wise in pressing the usefulness of their commodity in other fields than that of light, which is being so sharply assailed by electricity. Whether the directors really think rapid progress will not take place in the development of their rival for "a good many years," is best shown by these signs.

Edison in Paris.—Now that the Shah has left Paris the great scientific monarch of Menlo Park is the veritable hero of the hour and the theme of all tongues, writes the Paris correspondent of the *Daily Telegraph*. His fame is blown about on the brilliant Boulevards, the cafés ring with his name, and the leading newspapers are full of his remarkable career and his wonderful inventions. Pasteur, De Lesseps, and even Eiffel himself have been temporarily relegated to indifferent accommodation in the back part of the house, and the electrician occupies the front row all to himself. On Sunday the distinguished "scientist" arrived at Havre by the "Bourgogne," and he was met by dozens of friends, admirers, and interviewers, the latter discovering that he resembled an Anglican divine, Coquelin cadet, Dr. Charcot, and Agénor Bardoux all rolled into one. There were cries of "Vive Edison!" but the eminent electrician is not a *poseur*, and made his escape as soon as possible from the enthusiasts. On arriving in Paris, Mr. and Mrs. Edison, and the relatives who have accompanied them to Europe, went to the Hôtel du Rhin, in the Place Vendôme, where rooms had been taken for them. Yesterday morning the electrician left a card on the American Minister to the French Republic, Mr. Whitelaw Reid, and after luncheon had a drive round the city with Mr. Cutting. The inventor has admitted plumply that he has not come to Europe to be "lionised" in society, which he does not like. He is about to do the *grand tour* with his young wife as rapidly as possible, and to see Paris, London, Florence, and Naples. As for the scientific bigwigs, Mr. Edison says that he has not visited Europe to be presented to them, and hints that he cares as little about them as they seem to do about him. Mr. Edison paid a visit to the Exhibition on Monday.

Southwark Electric Subway.—At the meeting of the City of London and Southwark Subway Company held on Tuesday, the Chairman stated that the whole of the tunnels forming the subway were finished with the exception of a small piece about 250 yards long, between the Oval and the terminus at Stockwell, which was found

to be a piece of wet gravel, and had occasioned some delay. All the underground works for three of the stations were finished, and the works at the other three stations were proceeding very rapidly. In about eight weeks from now they hoped that the whole of the stations would be completed. They had also commenced the erection of two of the surface stations—at Great Dover-street and the Elephant and Castle. The surface station at King William-street was already standing—the buildings were there, and the lower part was now being altered into the permanent station. They had to provide a vast amount of machinery in connection with the working of the line, and they had purchased a large piece of land at the Stockwell end for the reception of the machinery. Considerable progress had been made with the works there. The permanent rails were laid almost the entire length in one tunnel, and part of the length of another, in the piece between King William-street and the Elephant and Castle. They hoped that the first preliminary trial train would be run before many days were over, but this would be only an experimental trial by the contractors. It was hoped that they would have been able to state what date the line would be opened for traffic; they were disappointed they could not do at present, but when it was remembered that the construction of the whole subway was perfectly novel, that the working power was new, and that the arrangements in many cases were entirely new, it would be understood how much thought and consideration had to be given to every detail so that there might be no failure when they came to open the line. Everything was being done to complete the undertaking with as much care and expedition as the nature of the work would allow. He hoped that the whole line would be opened within a reasonable time. The report was unanimously adopted.

Acheson's New Calelectric Generator.—There seems to be something solid, whatever it may eventually prove, under the wonderful claims for increasing the output of generators by heat recently sent from Pittsburg, to judge from the fact that three patents have just been issued to Mr. E. G. Acheson, of Pittsburg. "These," says the *Electrical Review* (New York), "give promise of at last achieving something substantial in the direct conversion of heat into electricity. One patent is to the method, one to the apparatus, and the third to a modified apparatus. In the same inventor's former apparatus he caused heat lines to traverse an electric conductor and produce a magnetic whirl, cutting said lines, so converting the heat energy into electric energy. Mr. Acheson now brings forward an invention which is somewhat different. He shows it both with and without a thermo-couple of the ordinary form. By means of an alternating-current generator in a circuit, which he prefers to enclose an iron core of the ring type, he produces magnetic waves, and these by induction impress an E.M.F. in a secondary circuit wound upon the same core; the apparatus thus far practically constituting a transformer. He then applies flame or other source of heat to the iron core at a point devoid of winding, and by some process, not clearly set forth in the patents, an additional E.M.F. is impressed upon the secondary circuit. This additional E.M.F., in the practical experiments which the writer had the pleasure of witnessing, can and does exceed the E.M.F. impressed by the primary alternating current; so that in reality the electric energy due to the inductive transformation can be doubled by the action of the new thermic transformer. The invention," adds the *Review*, "seems to be a distinct advance in electrical

development, and opens up a new field for the investigator. The announced results are too remarkable not to attract widespread attention and experimenting everywhere. The practical bearing of the invention will be grasped by our readers when we say that, if the 'Acheson effect' (if we may so christen it) is a reality, its application to existing plants of the alternating type would at once double their capacity without requiring any additional engine-power."

Naini-Tal Electric Railway.—Colonel Thomason, R.E., gives further views in the *Indian Engineer* to hand of this week, of the proposed electric railway. He mentions that water supply, by means of electric motor pumps, might be an advantage which could be looked forward to if there were current and electrical engineers on the spot. As to the railway, regarding the feasibility of which doubts have been very freely expressed by the Indian press, not by any means well posted as to the facts of the case, he continues: "Into the line which I have selected as the best below Nalena bridge, the old cart road enters very largely, but to what extent must depend chiefly upon the decision of experts at home (to whom I referred the question, and whose replies I await) as to the best form of electric railway suited to our case. There are three systems open to us from which to choose. 1. The accumulator system, with secondary storage batteries carried in the cars themselves. 2. The parallel system, with an overhead or underground conductor. (3) The series system, also with a conductor, which returns to the dynamo. The accumulator system, as being the most independent, has much to recommend it, having for years been most successfully worked in America under much more trying circumstances than any with which we have to contend here. It deals with zigzags with great facility, and would enable us to utilise the maximum of the old cart road, and so far be economical. The drawbacks to it are—the extra cost of working due to the depreciation of the batteries and the cost of carrying them—and they are heavy—and to the extra length of road. The parallel system with its conductor could also, no doubt, easily deal with zigzags, but is in some ways complicated on such grounds; the conductors are costly, and might, perhaps, be liable to interruption from falling rocks, trees, etc., and, finally, the adoption of any system of conductors would probably entail extra cost in the extension of our water works. The series system, though by far the most perfect, is, I fear, better adapted to heavy street, rather than to our comparatively light district traffic, and will, I suspect, be too costly for us." We are not by any means clear that Colonel Thomason is correct in his remarks upon the comparative values of the systems. It would seem rather that the difficulty of a storage system would be increased so far away from makers or repairs, and that a direct system would be preferable. As regards series traction, there is certainly nothing to prevent this system being used for long and light work, which would indeed, seem its proper function, as witness the sundry telfer lines now at work in England. The discussion, however, shows that the possibility of electric traction in India is being practically considered, and we trust the consultation with experts at home will result in the enterprise being carried out in a thoroughly successful manner. The opening of India as a field for electric enterprise should give great stimulus to the industry, and Colonel Thomason must be complimented on his energetic action in the matter.

THE EXPERIMENTAL DETERMINATION OF THE LAW OF VARIATION OF THE E.M.F. IN THE ARMATURE OF A WESTINGHOUSE DYNAMO.*

BY LEWIS SEARING AND SAMUEL V. HOFFMAN.

In the mathematical discussion of alternating currents it has been customary to assume the law of variation of E.M.F. as that of a sinusoid. Previous experiments to determine this law have been made upon machines containing no iron in the armature. Recently Dr. Louis Duncan, of the Johns Hopkins University, has conducted experiments in which he found that this assumption was approximately true with the Siemens machine.

We propose to investigate this law upon a machine containing iron in the armature. To observe the effect produced by varying the conditions we imposed the following:

- (1) Field current... 2.15 amperes; load = 0; speed = 1,000.
- (2) " " 4.3 " " = 0; " = 1,000.
- (3) " " 4.3 " " = 14; " = 1,000.

The machine used was the No. 1 Westinghouse dynamo in the electrical laboratory of the Stevens Institute, rated at 65 h.p., and requiring a current of seven amperes in the field when run at its full capacity. The power conveniently available being only a 35 h.p. Buckeye engine, accounts for the small figures taken for the conditions.

METHOD.

The method used was suggested by Dr. W. E. Geyer, of the institute, who had employed it as early as 1881 on a continuous-current machine. It consists in measuring the difference of potential existing between the brushes for an instant of time at any angular position of rotation of the armature, by charging a condenser and discharging it through a high-resistance galvanometer.

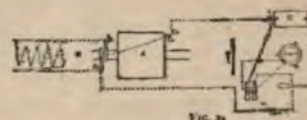


In the practice of this method it was necessary to devise some means of closing, for an instant, the shunt circuit across the brushes to the galvanometer, while the armature was in the desired position of rotation. To effect this the following apparatus was devised: A ring of brass, R (Fig. 1), was sprung around the turned portion of the bearing nearest the pulley, and to this was secured the piece A, to which, at B, was hinged the piece C, held against A by a spring and adjustable outward by the screw, D. At the upper end of C was secured a block of hard rubber, E, and to this was fastened the plate carrying the steel wire spring, F, by which contact was made with the steel piece, G, highly tempered and ground to an edge in the direction of its length. The steel piece, G, was fastened to the end of the armature furthest from the commutator, with its ground edge parallel to the shaft by means of a V-shaped brass, H, and at such a distance from the shaft as to just pass, in its motion with the armature, the contact-spring, F. In holding H to the armature, hard rubber was used as an insulator, and electrical connection made between it and one of the commutator rings by a rubber-covered wire running through the air space in the armature. Fastened to the bearing of the machine was a graduated arc of 120deg., concentric with the brass ring. A pointer, P, on A served to determine

the angular position, in degrees, of the armature at the moment of contact, at which time the E.M.F. existing in the armature was measured.

The contact-spring, F, as finally adopted, consisted of a steel wire 0.034in. in diameter, bent as shown in Fig. 6. One end was inserted in the hole K, and secured there by a set screw, and the free end passed through a hole, slightly larger than the wire, at J, sufficiently far to make contact with the rotating piece, G.

Fig. 2 is a diagram of the connections. A represents the wire of the armature; B, B₂ the brushes; M the main circuit; C₁ the steel contact-piece revolving with the armature, and connected with B₁. C₁ makes connection with the condenser, C, once per revolution by coming in contact with the steel spring, C₂, connected with the condenser by the line wire. B₂ is placed in connection with the condenser by the wire and the discharging key, as shown.



The necessity of placing the measuring instruments a considerable distance from the dynamo introduced a difficulty in the shape of self-induction, due to a long line. This we overcame as much as possible by using bare copper wire 0.008in. in diameter. This line was supported on glass rods, fastened to wooden supports, except for a distance of 7ft. where they were fastened to a pine board for protection, and for about 4ft. where they passed through glass tubing. The wires ran parallel 4.5in. apart their whole length, a distance of 150ft.

The measuring apparatus used was a "high resistance Thompson reflecting galvanometer," with its accompanying shunts $\frac{1}{5}$, $\frac{1}{10}$, $\frac{1}{20}$, and two mica condensers of one microfarad capacity (variable, etc.), all of Elliott Bros., London. The scale used with this galvanometer was placed 33in. from the needle and had divisions measuring forty to the inch.

The first difficulty experienced in measuring was that arising from the large static charge induced in the line wires and the metal of the machine by the action of the belts. The first step towards removing this was to connect the body of the machine with the ground, and to furnish pointed wire collectors to the belts, also connected with the ground. Although this removed much of the charge, there still remained enough to charge the 0.1 motive-force condenser, and give with the one-ninth shunt a mean but not very constant deflection of twenty-one divisions. As one volt gave a deflection of about three divisions with the one-ninth shunt, this would have seriously interfered with our measurements. At first, it was a question whether we were measuring the potential of the condenser due to the static charge, or that due to the dynamo. The following considerations, however, show that we were really measuring the E.M.F. of the dynamo; for, suppose the condenser had become charged from the belts, etc., to a potential greater than that which the armature would furnish, then, as soon as the contact-piece completed the circuit which includes the condenser and armature, the condenser would, by reason of its greater potential, immediately discharge itself through the armature until its potential equalled that of the armature, which is the E.M.F. we would measure. If, however, the condenser was charged to a potential less than that of the armature, then upon completion of the circuit, the armature, from its being able to supply an infinitely larger current than the belts, etc., would charge the condenser instantly to its own E.M.F., which is what we measure, as before. Moreover, our experiments showed that, in this particular case, the current from the belts required quite a perceptible time to charge this condenser, and give even a measurable charge. An additional fact that no error was introduced by this static charge is evident from the regularity of the readings, and the smoothness of the curves.

Two revolution counters were used during the test; the first was an ordinary one, which was held in place by hand while taking speed. This was superseded by a second, the pinion of which engaged with a worm inserted in the end

* Graduation Thesis at Stevens Institute of Technology, Hoboken, N.J., 1888.

of the dynamo-shaft. This counter was arranged to be thrown in and out at will, and the number of revolutions automatically recorded.

The order of procedure in applying this method was as follows: The dynamo and instruments for measuring potential being about 150ft. apart, in separate rooms, the observers in each room were connected by telephone and bell. The dynamos being started and everything made ready, signals were exchanged to that effect. Then the observer in the dynamo-room adjusted the contact apparatus for the first position, numbered 12deg., observed the indication of the ammeter in the field circuit, which, if not as desired, was made so by adjusting the resistance in that circuit, rang "go ahead" signal to the observer in the measuring-room, and upon receiving his answer threw in the speed-counter and noted the time. The observer in the measuring-room, immediately upon answering the "go ahead" signal, commenced a series of measurements of E.M.F. of the condenser, by noting the swing of the galvanometer needle, as follows: The charging key was placed in "charge" position and left there a few seconds. One reversing key was then closed, and almost simultaneously the condenser was discharged through the galvanometer. As soon as the galvanometer needle came to rest another charge was measured. These measurements occupied from three to four minutes. Upon the completion of each series of measurements, "go ahead" was signaled to the dynamo-room for the contact to be changed to the next position, and the above operations repeated. Speed was usually counted for three minutes, or nearly the whole time of measuring, and therefore the average speed for each series was obtained quite accurately. The variation in the field current during a series was never over 0.2 of a division = 0.04 ampere, hence no correction has been introduced for this. The speed in some cases changed quite perceptibly. To be able to make a correction for this, we determined the law of variation of E.M.F. with the speed in this machine. To do this, we made simultaneous measurements of speed and E.M.F., the latter at position of contact apparatus which gave the highest readings, i.e., 34deg., a point in the upper part of the curve. This law, as represented by a curve, showed a direct variation, it being almost a straight line. Upon this the corrections for speed were made, the value of the E.M.F. being computed for 1,000 revolutions per minute.

At the beginning and end of each run, which occupied about four hours, any variation of H was observed by noticing the swing of the needle produced by the condenser when charged from a cell of Leclanché battery, kept especially for that purpose. The variations were so slight that they have not been introduced in our corrections.

The corrections to be applied to the readings of the galvanometer were:

- (1) A geometrical one, from the fact that the swing of the spot of light measures the $\tan. 2\alpha$, while the charge is proportional to $\sin. \frac{1}{2}\alpha$.
- (2) A correction due to the induction of the shunts.
- (3) A correction for the ratio of the shunts.
- (4) The resistance of the air to the swing of the needle.
- (5) The correction for speed.

The first, second, and fourth corrections were obtained in one experiment, by comparing six gravity E.M.F. cells, which were approximately of the same E.M.F. by the condenser method. Then by using one of the shunts employed in the regular work, we noted the swing produced by 1, 2, 3, and so forth cells coupled in series. Knowing the exact comparative values of E.M.F. which the coupled cells ought to give, and by experiment the swing they did give, and taking the latter for ordinates and the former for abscissæ, we obtained a curve for converting the one into the other. This curve approached very closely to a straight line, the ordinates (or galvanometer readings) of which are about 4 per cent. greater than the abscissæ (or E.M.F. values). This correction was made graphically.

The shunt ratio and induction correction were obtained in one experiment, and amounted to 0.76 of 1 per cent., which was neglected.

The correction for speed was also made by the graphical method, and afterwards tested by logarithms.

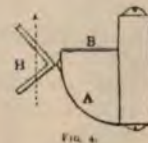
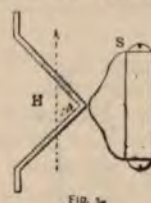
The instrument used for measuring the field current was

a portable Thompson galvanometer, and for measuring the main current of the Westinghouse, the Westinghouse ammeter usually accompanying the machine, which was previously calibrated by a continuous current. This instrument could not be relied upon within 0.25 of a division with the current we used.

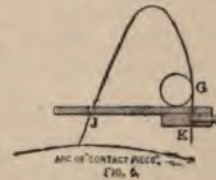
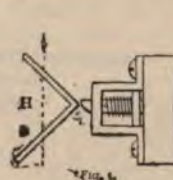
The main circuit was through a large german silver rheostat, strung overhead in the dynamo-room. When running at night, some of this current was used for lighting.

SPRINGS.

Upon the apparatus for obtaining almost instantaneous connection between the armature and condenser, or, more strictly, upon the pieces which come in such rapid contact, 1,000 per minute, depends the success of this method. Our difficulties and the manner of overcoming them may be of assistance to others. In the first arrangement of these pieces the end of the brass V, H (Fig. 3), which was fastened to the revolving armature, came in contact with the spring, F, made of a strip of spring brass $\frac{3}{8} \times \frac{1}{8}$ in., and bent in the form shown in the figure. With this spring the wear was such as to cut through the thin brass in about two hours, and as this wear materially lengthened the arc of contact, we were compelled to abandon it. We then



replaced the brass spring with pieces of clock spring, of several widths and thicknesses, tempered throughout, softened at ends, softened at the middle, and softened throughout, but even the most durable of these did not last over an hour. The majority of them broke at S. We then tried the brass spring again, this time capped with steel at its point of contact to prevent wear. This lasted about two hours. We next tried a heavy brass spring ($\frac{1}{2} \times \frac{1}{32}$), tipped with steel, made as shown in Fig. 4. The part A has a spring outward and is held in check by B. The object of restraining the outward tendency of A is an important one, and is to shorten its time of vibration to much below 0.001 minute. The next arrangement is shown in Fig. 5. The piece H in passing struck against a steel pin, which action forced it inward against a light spring coiled about it. This arrangement produced such a jarring and such a wear on H as to make its use impracticable. From the experience of these springs, we learned the causes of failure; one, that the springs used were much too heavy, and another, the most essential, that the path of the contact



point of H was parallel to the surface of the part with which it came in contact, producing a direct blow and slide; whereas the path of each should have been tangent to each other, in order that the parts would approach and immediately recede, thus allowing, by means of the adjusting screw, a contact of almost any delicacy. The longer the arc of contact, the result of construction or wear of parts, the greater the variation between readings taken at any point in the curve. To prevent this, we arranged to have a knife-edge of hardened steel strike the end of a very light steel wire spring (0.034 in. diameter), as described in a former part of this paper.

The first spring used was bent as in Fig. 6, but without the coil at G, and broke at the point where it was clamped by the set screw, before the end of a run. We then coiled it twice at G, care being taken in fastening it to have the coils press firmly against the plate, in order that the bending should be confined to the coils. These springs would last about six or seven hours, and were readily and

accurately replaceable; so, to avoid the annoyance of breakage, a new spring was used for each run. We then obtained a clear yet light contact that was in every way desirable.

TABLES.

Tables giving the results of the observations were made, a very short abstract of one being here given to illustrate the form.

Column 2 gives the shunts used, and as the condenser was generally the same value throughout a run, its value has been placed at the head of the tables and any change noted in the columns of "Remarks."

Column 3 contains the actual readings (right and left) made on the galvanometer scale.

Column 4 is the mean of these readings reduced to a value which would be given by the $\frac{1}{v}$ shunt.

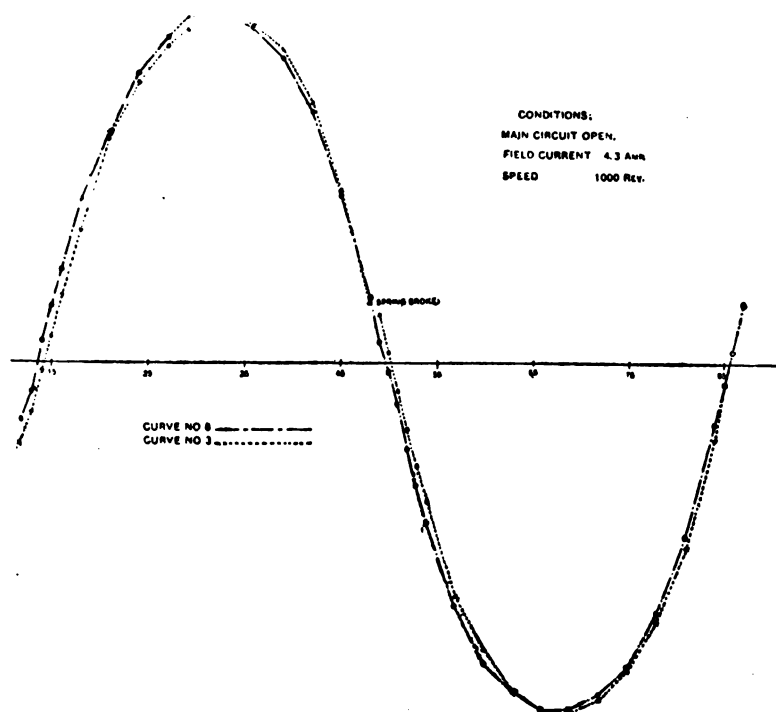


FIG. 7.

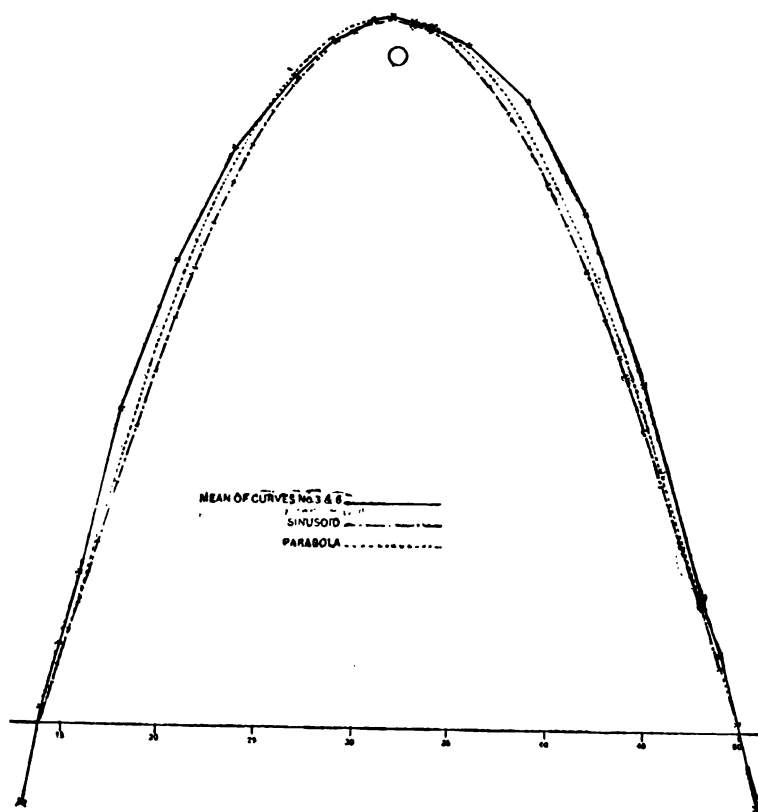


FIG. 8.

The first column on the left gives the position, in degrees, of the arc previously mentioned, at which contact was made. This arc, of which the 0deg. was arbitrarily assumed, was for the purpose of measuring the abscissæ of the curve, and for determining the position of the armature-coils in reference to the field-magnets for any E.M.F. in the armature-coils. The 0 of the curve happened to come between position 14deg. and 15deg., and as the readings about these points were uncertain, we started measuring at a point a *trifle* before the curve cut the axis.

Column 5 contains the readings with all corrections applied, but reduced, as in column 4.

The remaining columns explain themselves.

These curves were taken under the same conditions, in pairs, so as to verify each other, as in Fig. 7, and then the mean readings of the two plotted, as in Fig. 8. In order to show how closely they follow the "sine law," a sinusoid has then been traced over them and is the inner line, Fig. 8, and as will be seen on inspection, the agreement is quite close; the most marked difference occurs between the

CURVE No. 1.

Conditions.—Main circuit consisted of about 36 ohms german silver wire in parallel with 11 lamps of 16 c.p. in series. Field current, 4.3 amperes.

1. Microfarad Condenser.

May 8, 1888.

Pos.	Shunt.	Readings.		Mean Reading.	Cor- rected Mean Reading.	Speed.	Current in Main Circuit.
		Left.	Right.				
Deg.							
12	1—99	-46 46 48	43 43 44	45·	47·	952	14·0
13	1—9	-235 233 236	263 261 262	27·2	27·	955	14·0
14	1—9	-68 63 48	65 54 52	5·7	5·8	965	14·0
15	1—9	+98 61 95	100 45 101	10·08	10·	956	14·0
16	1—99	+33 32 32	50 31 31	31·5	33·	930	14·0
18	1—99	+64 68 66	63 63 62	64·3	67·	947	13·7
21	1—99	+114 115 116	108 109 109	112·	114·	957	13·7
24	1—99	+151 148 150	138 140 140	144·5	149·	951	13·7
27	1—99	+173 173 175	160 164 163	168·	172·	949	13·7
29	1—99	+182 181 181	167 167 167	174·1	178·	952	14·0
54	1—99	-75 76 73	70 71 70	72·5	75·	943	13·9
57	1—99	-118 119 119	112 113 111	115·3	119·	946	13·9
60	1—99	-150 150 150	141 141 141	145·5	147·	936	13·7
63	1—99	-174 171 173	161 163 161	167·1	173·	943	13·9
66	1—99	-186 184 184	173 181 181	181·5	187·	942	13·9
69	1—99	-190 189 190	175 175 175	182·3	188·	938	13·9
72	1—99	-184 186 187	172 173 173	179·2	185·	943	13·9
75	1—99	-172 172 172	160 160 161	166·1	171·	943	13·9
78	1—99	-147 145 144	136 136 135	140·5	145·	949	14·0
81	1—99	-98 103 99	97 95 94	97·7	101·	950	14·0
...	...	...	...	...	...	...	...
84	1—99	-42 44 45	44 43 45	43·8	46·	943	14·0
85	1—9	-193 193 186	182 180 184	18·63	19·	943	14·0
86*	1—9 0	+7·0 +9·8 +235	...	84	85	958	14·1
87	1—9	+238 238 210	203 203 190	21·5	22·	943	14·0

* E. M. F. readings very variable.

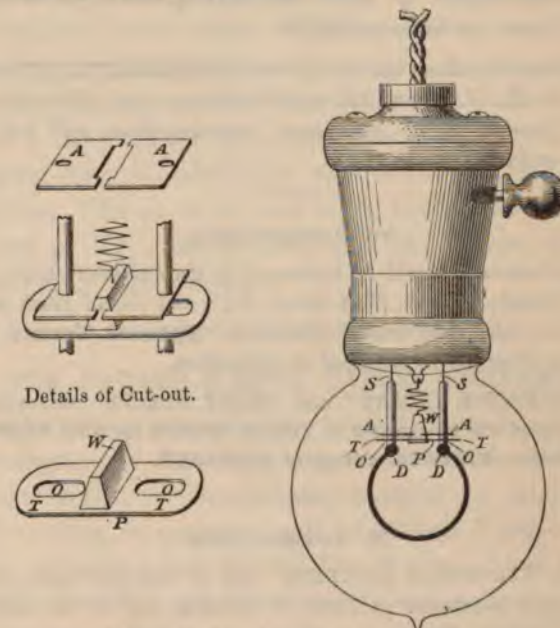
positions 16deg. and 27deg., 36deg. and 48deg., and on the reverse curve, positions 52deg.-63deg., 72deg.-84deg., where there is a sort of bulging out in the direction of rotation of the armature. The cause of this is not known, so far as we are informed.

The direction of rotation of the armature is shown by the arrows.

Fig. 8 shows only one branch of the curve. Over this curve has also been traced a parabola, the focus being at the point O. While the curve cannot be said to follow the "parabola law," as it has two branches, and the parabola only one, still it will be noticed that the parabola is much nearer the true curve, for one branch only, than the sinusoid.

GOLDSTON'S SERIES INCANDESCENT LAMP.

As mentioned in our account of the Birmingham Electrical Exhibition, Mr. A. A. Goldston is showing a system of series incandescent lighting for arcs and incandescents combined, for public and private lighting. Mr. Goldston has patented a new combination of series incandescent lamp and cut-out, the details of which we illustrate herewith. The Edison and Swan Company are undertaking to manufacture these lamps which it is Mr. Goldston's intention to introduce, with other patented apparatus, as a complete series incandescent system.



Goldston's Series Incandescent Lamp, with Cut-out.

In these lamps, which are intended to be used with a 10 ampere current, the filament is a thick loop of carbon. The connecting pieces, S S, are springy pieces of platinum, each of two or more wires, which would allow the loop to be bent about in any reasonable direction without altering the distances of the points of connection, D D. The platinum wires are only used to pass through the glass, and below these a piece of less costly conducting material joins the carbon to the wires. To each of these conducting pieces a plate of german silver, A A, is fastened of the form shown more clearly in the details. Underneath these a glass or china wedge, W, is fixed upon a short-circuiting plate, P, and is pressed upwards between A A by a spring. As long as the loop of carbon remains intact, and the circuit through the lamp is therefore complete, the tension is maintained at the points, D D, and the wedge keeps its place. At the moment of breakage of the loop the tension is released, the wedge forces apart the plates, A A, and the short-circuiting plate, P, completes the circuit at T T, allowing the current to continue without interruption. The short-circuiting plate is slotted at O O in such a manner that no short circuit occurs in ordinary use.

The lamp is also furnished with a short-circuiting switch on the holder. The holder itself is so constructed in its fittings that the lamp cannot be taken without turning this switch to complete the circuit until another lamp is replaced in the socket. This lamp, having a series cut-out inside the bulb where no tampering can interfere with it, and which must act immediately the lamp goes out, is a very ingenious solution of the series incandescent lighting problem.

THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence ; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices :

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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IMPORTANT NOTICE.

We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No paper that we know ever refuses Subscribers or Advertisers. Nor do we; in fact, we invite them, believing that they will get full value for their money.

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EDISON.

No, with every desire to give Edison his due, with every desire to credit him with all he has done, and in addition to add a good percentage of safety margin for what he is by some held to have done—we are not going to admit that he is the only living representative of the race of practical electricians. The daily papers report that Edison is in Paris, and one of our evening contemporaries, on the authority of Colonel Gouraud, says he is not coming to London, and then goes on to deplore the fact—a fact about which, however, we may have our own opinions—telling us that Edison would enlighten the authorities on the question of lighting London by electricity. No doubt, in a way, he could, so could many a schoolboy, for our worthy local governors do not pretend to any technical knowledge of the subject. The intense desire to say something smart, to pretend a knowledge where knowledge is not, to pose as ubiquitous instructors upon every subject abstruse or simple, frequently leads our political contemporaries to publish what is worse than incorrect, in that it reaches the eyes of the uneducated and is accepted as gospel, "for it is in print." There is no possibility of counteracting the evil, for those who read these delectable articles do not read technical papers. It is so in this case, but to pass by such statements means permitting gross libels upon the capacity of English electrical engineers to pass as current coin. If these advertising puffs mean anything, they are meant to be taken that Edison is far and away superior to any contemporary engineers in this country. This is a proposition we emphatically meet with a decided negative. Some years ago Edison was a name to conjure with, but its value was gained through the ignorance of the audience appealed to, and the systematic and untiring assiduity with which the business men surrounding him advertised and puffed the inventor and his inventions. Those who know anything of electrical subjects know that Edison is much about the same as other inventors—he has commenced in darkness, failed again and again, gained light from his failures, and in certain instances succeeded in the end. His successes in most cases have been of the nature of improvements. The difficulty, perhaps, is in the successes being so small, when we consider the untiring energy, the unlimited perseverance, the large expenditure, and the talented assistance he has had at his beck and call. The success of Edison in America, as regards electric lighting, is proportionally no greater than that of Westinghouse or Thomson-Houston. Pinning down these irresponsible writers to a definite point, we would ask them to consider upon what particular point he has given the world anything superior to what it has obtained from other inventors. His name can never compare with that

of Gramme in dynamo machines. He must stand on the same pedestal as Swan, Lane-Fox, and others as regards incandescent lamps, and divide the honour of devising the three-wire system with Dr. Hopkinson. Almost as important an advance as inventing a dynamo are the investigations which make it possible to "specify" a dynamo, and with all due humility we claim this progress for Englishmen. If Edison is the man we have always taken him to be, he would be the first to repudiate the idea that he claimed "infallibility" in matters electrical. Admittedly he is a man among men—and a big one, too—but he cannot come straight from New York or Paris and tell us more about the London lighting than we can tell him. Like the parson, if he has to preach he must get up his parable, and the information required for such teaching as we are told he can give us is not derived from introspective imagination, but from an arduous study of facts. A dozen people in London have the facts at their fingers' ends, and some one or more of these would have to enlighten Edison in every direction before he could attempt the rôle of prophet. Now that we have indicated the position we regard Edison to take in the ranks of electrical engineers, we have to say that our information as to his movements differs from that given above. A man standing in the front ranks of electrical inventors, is a man his English confrères will delight to honour. They will heartily welcome him to this country, and be glad to reciprocate the courtesies many have met with on the other side of the Atlantic. If there is one thing the Americans shine in next to advertising, it is in hospitality. The door is open and you are welcome without any reservation whatsoever. The same trait of character is to be found in Canada, in Australia, and other colonies of the Anglo-Saxon. It is characteristic of the race, and will not be found wanting when the great "American wizard," as he has been called, lands upon our shores. The difficulties he has had to contend with from youth upwards have been great, and, therefore, the name he has made and the success he has attained are all the more commendable. His inventions have not succeeded in taking firm root in this country, but that, without detracting from their value, tends to prove our contention; or we are very unpractical and use a shadow when we ought to use the substance, or in other words, use an inferior article when the superior is proffered to us. We hardly think this is the case. The great aim is to get simplicity combined with economy, and in these days of competition engineers are not likely to overlook or to put aside any apparatus that conduces to this end. It may be well, once more, to tell our contemporaries that the great progress of electric lighting in America is due to causes which do not exist in this country. Here its competitor is cheap gas; there it is dear gas, or no gas at all. In the

latter case it ought to be evident that the chances of the new system are much better than when houses are filled with gasfittings, and any alteration will cause expense and inconvenience. It is not a good reason to give, that because certain things happen in one place they ought to happen in another. All the conditions must be considered, and if they are in the case of electric lighting we ought to acknowledge that the English are not so bad after all. To return once more to our immediate subject, we regard Mr. Edison as standing in the very first rank of inventors, as being able both to teach and to learn on special points. One peculiarity of the man has always struck us as giving the best and clearest insight as to his great ability. It has been our lot to be more or less intimately acquainted with many of his assistants, and from first to last we never heard a word of disparagement uttered by anyone of them. They all believe in him: the pedestal upon which they place him is far higher than is usually the case with a man's intimates. But so it is, and were there none other proof of his great powers, this fact alone would ensure his high position.

THE FOWLER-WARING CABLES COMPANY.

Elsewhere we give the greater portion of the prospectus of this company, which seems to have been formed to amalgamate competitive interests. The cables, as manufactured by Messrs. Fowler and Co., of Leeds, and also by Mr. Waring, have been fully described and illustrated in our columns, and must be well known to our readers. The directorate is an exceedingly strong one, and includes the well-known Nitrate King. With regard to the prospectus, it errs, like all prospectuses, in being somewhat indefinite. The facts, as stated, of course, we are bound to admit, while some of the inferences may be debateable. There is no doubt about the necessity of putting wires underground in busy and populous centres, and once that necessity is accepted it becomes of importance that the work should be so good, and the materials employed so imperishable, that the cost of maintenance should be a minimum. The first cost of laying underground mains will always be large, even if subways become general, but that, as a rule, is not a preventive to business. When once the mains are laid they are wanted to remain highly insulated, with as little deterioration as possible. It is not the initial cost but the maintenance that kills business. Whether the company now formed possesses perfect cables for underground work is a question time alone can decide, but, at any rate, as time goes on, if improvements are made, the company will have no difficulty in adopting them. With the progress, not only of electric lighting, but also of telephony, there

must be a large field of operations open to the manufacturer of cables. Attention should be directed to one point in this prospectus which shows that business is meant. The purchase money comes to only forty-one two-hundredths, or, say, one-fifth of the capital, whereas in a gigantic concern recently offered the purchase money was forty-one fiftieths, or about four-fifths of the capital. According to the catalogue of the Waring Company, their cable is largely used in America, and a large number of testimonials are given as to its value. In these cases the testimony of someone who has used the material is of far greater value than anything that can be said for or against by a non-user, and all persons interested should make a point of seeing the testimonials.

THE LAW OF PROBABILITY OF ERROR AS APPLIED TO THE OBSERVED ELECTRICAL RESISTANCE OF THE HUMAN BODY.

BY A. E. KENNELLY.

It is generally admitted that all social phenomena are in the aggregate controlled by the general law of probability of error, and statistics, it is claimed, show that the proportions, weight, intelligence, and, in fact, all measurable properties of animated beings, at any given time and place, centre about some mean value, the divergences from which follow the law of probability of error in observations. This leads to the inference that Nature endows all organisms with slight variability of type in a high degree, any one quality being the resultant of a great number of factors, so that the general mean is reached through the summation of all possible variations of those factors, as many variations being ultimately positive as negative. The law has probably not been stated for the measured electrical resistance of the human body, but the following observations may fairly be said to indicate its application:

Two hundred and twenty men and boys were measured at Mr. T. A. Edison's laboratory for the resistance they offered between the hands with liquid contact. The measurements were all made on the same day, and as nearly as possible under the same conditions. Two glass jars, 15 centimetres (6in.) in diameter and 20 centimetres (8in.) deep, containing an aqueous solution of caustic potash (density 1.10), were connected by immersed copper sheets, 15 centimetres $\times$ 29 centimetres (6in. $\times$ 15 $\frac{1}{2}$ in.), with a Wheatstone bridge. The reason for adopting caustic potash solution was that in a previous test with 39 men their mean resistance between the hands immersed in this solution was found to be 30 per cent. less than when aqueous zinc sulphate solution, of density 1.13, and zinc electrodes were used, all other conditions remaining unaltered.

The testing battery had a low resistance and an E.M.F. of eight volts. The bridge ratio was $\frac{1}{10000}$, and with the dead-beat galvanometer employed, readings could easily be taken to one ohm in 2,000.

The measurements were made in such a manner as to eliminate almost entirely the effects of polarisation. Under these circumstances it was found that between the limits of the feeblest current by which an observation could be obtained and the strongest current that on starting or interruption could be conveniently supported by the men (about five milliamperes), the measured resistances were practically independent of the current strength, and, consequently, of the battery power employed. The resistances, however, decreased with the surface area of immersed skin, and also with the period of immersion, in many instances falling about 100 ohms in the first 30 seconds. To obtain comparable results, therefore, the hands of the person tested were plunged, pointing vertically, downward into the

jars until the tips of the middle fingers rested on the bottoms, and the measurement was made as closely as possible 30 seconds after immersion. The readings were carried to the nearest 10 ohms, units being negligible even if the resistance had been steady enough to render them distinct. The variations in these measurements would include not only differences in the resistance of the arms and trunk, but also the variations of thickness in the epidermis, area of hand surface, as well as errors of observation and time. All these disturbing conditions, however, may be regarded as belonging to the class of observational error, and simply tend to make the measurement of the resistance within the body less precise. The age, height, and weight of the subject were recorded with each observation. No dependence of the resistance upon these qualities could be noticed, but the boys had apparently a higher resistance and stoutly-built men a low resistance. Thus the four boys of ages under 16 gave an average of 1,218 ohms, while the nine cases of men, whose weight exceeded 175lb., gave an average of 770 ohms.

The average of all the 220 measurements was just 1,000 ohms, and the sum of the divergences from this mean value taken without regard to sign was 27,920.

From these data we obtain by the application of the usual approximate formulæ of probability the following table in which the actually observed and calculated divergences are compared.

Divergence between.	Calculated number of cases.	Observed number of cases.	Difference.
0 and 50 ohms $\pm$	54	47	7
50 ohms and 100 ohms $\pm$	49	56	- 7
0 and 100 ohms	— 103	— 103	— 0
100 ohms and 150 ohms $\pm$	41	38	3
150 ohms and 200 ohms $\pm$	30	40	- 10
100 and 200 ohms	— 71	— 78	— 7
200 and 250 ohms $\pm$	20	13	7
250 and 300 ohms $\pm$	13	10	3
200 and 300 ohms	— 33	— 23	— 10
300 and 350 ohms $\pm$	7	7	0
350 and 400 ohms $\pm$	3	1	2
300 and 400 ohms	— 10	— 8	— 2
400 and 500 ohms $\pm$	2.6	4	- 1.4
Over 500	0.4	4	- 3.6

The agreement is seen to be very fair, except that there were more large discrepancies of over 500 ohms than theory would account for.

The highest observed resistance was 1,970 ohms and the lowest 660 ohms.

Under the conditions of this test, therefore, it was an even chance by the theory of probability than any man's resistance would be within 108 ohms of 1,000—i.e., would lie between 892 and 1,108. As a fact, 115 out of the 220 observations fell within those limits, so that the final result of all the measurements was 1,000 ohms $\pm$ 108.—*Electrical World*.

MECHANICAL DETAILS OF ELECTRICAL MACHINERY.

BY A. J. SHAW.

In the practical application of electrical machinery to heavy work, more failures have resulted from lack of sufficient attention to mechanical details of construction than from any other single cause, if not more than from all other causes combined. Many electricians have never learned to look upon electrical machinery as anything more than laboratory apparatus. This may be due to the fact that they are scientific experimenters, and not mechanics. This is not universally the case, however, for that some are fine mechanical as well as electrical engineers is shown by the character of their work.

In designing dynamos and motors for heavy duty, a liberal margin should always be allowed for overloading, abuse, and neglect, not only in the electrical portion of the apparatus, but in all the mechanical details as well.

Brush-holders in which the brushes are held in place by small nurl head screws, binding posts and flimsy con-

nectors in or to which still more unsubstantial screws are expected to secure large conductors, are things which one would hardly expect to find on dynamos and motors from reputed first-class makers; but one does find them, nevertheless.

Screws for connections should have square or hexagonal heads in all cases when possible, and set and binding post screws should have heads of the same shape. Screws requiring too frequent adjustment to make the use of a wrench undesirable should have liberal "wing" heads or heads with cross-pins. Nurfled heads are an abomination, and should never be used on heavy machinery under any circumstances.

Screws to which connections are made by twisting the wire around them should be especially substantial, and should in all cases be provided with liberal washers.

In many engineering establishments it is one of the unwritten rules never to use a set screw less than, say, $\frac{3}{16}$ in., or a bolt less than $\frac{1}{2}$ in. or $\frac{3}{4}$ in. in diameter, except by "special dispensation." Even when the nominal load on the bolt is such that it might be carried by one that is much smaller, it has been found the only safe way to allow a liberal margin for contingencies; such, for instance, as a burly labourer at the end of a monkey wrench. Similar rules, modified as to the sizes of the bolts and screws to be used, should apply to heavy electrical work.

The "factor of safety" has been called a "factor of ignorance." It should sometimes be based on the ignorance of the user.

A motor designed specially for very heavy duty in a situation where anything more than the most ordinary care was not to be expected, was provided with connectors having $\frac{3}{16}$ in. slot-headed brass screws for securing conductors of No. 4 A.W.G. wire. It is, perhaps, superfluous to state that some of these screwed themselves off, instead of in, and had to be replaced with screws of iron.

Not only are liberally proportioned screws less likely to get broken, twisted off, or otherwise crippled, than the imitation fastenings often furnished, but better contacts, and consequently less trouble from heating as well as a higher electrical efficiency, are obtainable, as the larger screws can be set down hard enough to exert a reasonable degree of pressure.

There is a motor in the market, the brush-holders of which are pitted with brass screws about $\frac{3}{16}$ in. in diameter with nurfled heads about $\frac{1}{2}$ in. in diameter. One of these screws is supposed to be sufficient to clamp the brush securely in place. It did hold for a short time, when the brush slipped, was readjusted, and soon slipped again. This time a persuader was applied, in the shape of a pair of pliers, and the brush did not slip again.

When it became necessary to readjust the brush on account of wear, the set screw seemed disinclined to let go. On inspection it was found that the part of the screw between the point and the yoke, into which it was tapped, was somewhat larger than when made. The screw was finally gotten out, but the thread in the holder was ruined. It was then tapped $\frac{5}{16}$ in., and fitted with an ordinary case hardened, square head, set screw. This is not quite as handsome, from the apparatus makers' stand-point, as the original arrangement, but it is much more satisfactory to the man who runs the motor.

Set screws of brass, especially of the soft yellow brass rod commonly used, are a nuisance, as the points invariably upset as soon as any attempt is made to screw them up tight. There are situations in which iron or steel set screws are inadmissible, but they can be used in nine places out of ten in which those of brass are considered the only orthodox thing. Some makers of fittings are using them quite extensively, and it is certainly a start in the right direction.

The brass yokes which carry the armature bearings are sometimes very weak. This state of things arises, no doubt, from a laudable desire on the part of the maker to economise in the weight of brass, although in many cases it is due simply to bad design, as there is sufficient metal in the yokes to make them amply rigid, if it were properly disposed.

In motors from which the power is taken by a belt, this weakness is not always so perceptible; but when a

pinion on the armature-shaft is substituted for the belt pulley, the lack of strength may become only too apparent.

There is scarcely any single mechanical detail in a dynamo or motor in which weakness is more fatal than in the armature-shaft, and yet this defect is not uncommon. On account of the high speed at which they run, armature-shaft bearings are necessarily made very long. On this account, in order that they may not deflect in their own length, the diameter should be considerably greater than that due to the torque alone. A long bearing which springs is worse than a short one which is rigid; and a bearing which is amply large, as far as ultimate strength is concerned, may deflect very appreciably when subjected to the cross-pull of the driving-belt or the reaction of a small pinion.

In one case, that of a motor, the power of which was transmitted through a small pinion, as in street car work, the bearing next to the pinion was worn very badly in a very short time, apparently from this cause alone—the weakness of the shaft. The low surface velocity of the journal due to the small diameter is very desirable, but is paid for too dearly when obtained at a sacrifice of strength. Any increase of velocity of sliding due to an enlarged diameter is partially, if not entirely, compensated for by the increase in the bearing area and the reduction of pressure per unit of surface. Switches are frequently constructed in a very unsubstantial manner, with insufficient surface and poor contacts. In a certain reversing switch, the insulating surface on which the sliding block runs after, leaving the last block of the rheostat, is of wood. This wood wears away quite rapidly, and the process is hastened by the temporary arcs formed between the blocks on breaking contact, and finally the wood surface has become so much lower than the rheostat blocks as to render the operation of the switch somewhat difficult.

In a switch designed to control a motor attached to machinery in a foundry the rheostat lever was connected to the hand lever by a light bar pivoted on the points of small headless brass screws. No provision was made for preventing the loosening of these screws except the tightness of their fit in the threads. Owing to a change in the arrangement of the machinery, this switch was not used. How long it would have remained in working order under the conditions necessarily obtaining in a foundry, ought not to be difficult to predict.

Sliding contacts can hardly be made too large; it is very easy to make them too small. On this account sliding contacts are preferable to rolling contacts, wherever it is possible to use them. Rolling contacts conveying heavy currents are troublesome things, as everyone who has tried them can testify. This does not apply to the higher voltages and smaller quantities used in street car service.

Not all electrical machinery is open to the criticisms made in the preceding paper, as there is much which is fully up to the standard of the best mechanical work in design and construction.—*Western Electrician*.

THE EDISON THREE-WIRE SYSTEM OF DISTRIBUTION.*

BY W. J. JENKS.

(Concluded from page 120.)

A method by which the Westinghouse Company have recently (1887) undertaken to secure the same result is shown in Fig. 19. Here the water necessary to operate a given number of motors on each side is constantly raised to a given height, the compensating conductor being brought back to the source of energy, but not being connected in such a way between the two poles as to regulate the work done, the balance between the two being made good by the introduction of a choking valve, corresponding to electrical resistance, by which the flow of water in the compensating conductor can be varied in accordance with the varying conditions of the circuit outside. Thus, as in the practical operation of plants, there is always a greater or less difference between the load on the two sides of a system. In this method a certain amount of power is

* From the *Electrical World* (New York).

always wasted by being discharged, as it were, through useless resistance at the station.

It has often been stated that the methods of the three-wire system were anticipated in the plan adopted for the installation of United States plants in the Amoskeag Mill, at Manchester, N.H., and in the building of the Boston Herald. In each of these cases two arc light dynamos were placed in series, a number of lamps operated by each, and a wire from midway to the total circuit of lamps returned to a link between the two dynamos. This is shown in Fig. 20. It requires but a moment's thought, however, to discern the radical difference between the operation of such a method and that of the Edison three-wire system.

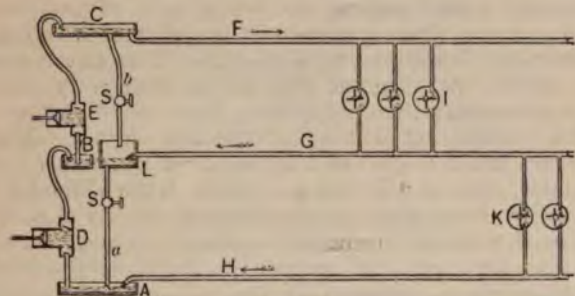


FIG. 19.

The arc light circuit depends for its normal operation, as well as safety, on a constant current. If, for example, one of the lamps shown in Fig. 20, as operated by dynamo D', were to be turned out, an increased current would instantly be sent through the remaining three, the normal quantity continuing on through the second group of lamps and to the dynamo D, while the increase would make its way along the middle wire to the dynamo D', thus stimulating its magnets and further increasing its output. Thus the middle wire in such a system would become, not a source of compensation, but of danger. In fact, the entire motive for its temporary use in these two systems appears to have been the distrust naturally felt in the early history of the art with relation to the reliability of the machines themselves. Hence this middle wire was an "emergency" conductor, merely serving to keep in operation one-half of the system if the other half broke down. The best evidence of the fact that it was not only useless but dangerous is found in its abandonment by the company, as no other plant is on record as having been thus equipped.

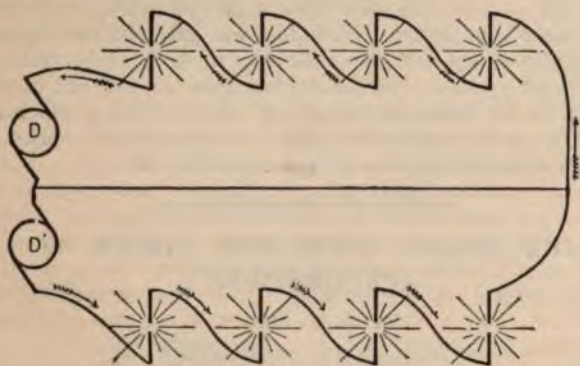


FIG. 20.

With the further practice in the arc light field these original ten-light machines were supplemented by others of larger capacity, and greater faith in the reliability of the apparatus caused constructors to omit any such "emergency" wire as being not only a source of possible danger to the system, but a useless outlay in copper.

A SUMMARY OF ADVANTAGES.

The Edison three-wire system presents, therefore, several points of special interest which may be briefly summed up under four heads:

1. A compensation at the source of energy for the difference between the total output of one side and that of the other.

2. An intergroup compensation between the different

clusters of lamps in the same main, or in adjoining buildings.

3. The retention of the old multiple arrangement, by which the individual control of lamps is secured, coupled with the reduction of the expense of conductors to three-eighths of the previous amount.

4. The result of all these favourable conditions, making comprehensive systems possible with a reasonable expenditure of copper in conductors, and rendering it easy to make such systems profitable, as the record of a large number of stations has for years demonstrated.

The extent of reduction to which Mr. Edison has thus carried the three-wire system has sometimes been criticised on the ground that it is not in harmony with the principle established by Sir William Thomson and others—viz., that the "additional running expense due to the resistance of the conductor shall equal the interest on its first cost." While this principle undoubtedly applies, in the light of present experience, to arc circuits where the load is practically constant, it cannot be economically enforced in all, or in perhaps in a majority of cases, where, as in a central station incandescent plant, the percentage of heat waste varies from hour to hour, attaining a maximum during an hour or two each week, and cannot be computed in advance for any given system, as an average can only be arrived at as the result of actual observation, and the point of greatest economy, for one system cannot be quoted as a guide for another, in which the hours of lighting may differ widely. In point of fact, it has thus far been found desirable to vary the percentages of maximum loss in feeders and mains of different systems according to local circumstances, chief among these being the cost of producing power.

DISTRIBUTION BY FEEDERS AND MAINS.

One of the most interesting features of the Edison system is the method of carrying out this idea in distributing the current through the streets of a city. This may, of course, be done either by underground conductors or pole-lines, though in large places the size and number of wires, and the fact that the poles should not be more than 100ft. apart, makes the inconvenience almost equivalent to a prohibition. Where an underground system is impracticable on account of scattered buildings, as in many residence districts, it is often advisable to erect poles along private ways or alleys, or even between these, on the rear lines of estates, where they will prove least objectionable. If thoroughly constructed of the best material, overhead lines offer many advantages in some localities, and cost originally only about one-quarter as much as a tube system.

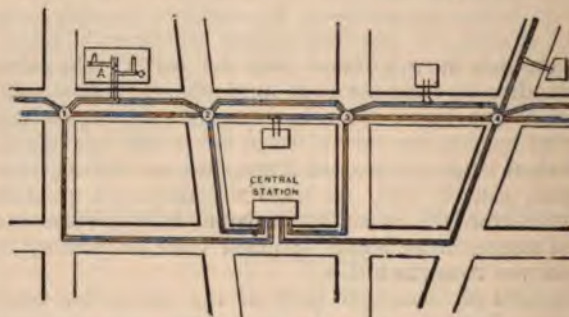


FIG. 21.

To illustrate the principal features of either plan let Fig. 21 represent an underground installation in one street, with the station as near as possible to the centre of consumption of light. A main is laid on each side of the street, about two or three feet from the kerbing, and connected at convenient intervals, usually at the intersection of crossing avenues, with junction boxes, which are in practice buried near one corner of the sidewalk nearest the station, very much after the manner of the street hydrant. Each main contains three wires, and the positives, neutrals and negatives of all the different mains of the system are connected at the boxes each to each, as if in a single line. Feeders are now run from the station to the junction boxes, their several resistances so calculated that the greatest supply

of current shall be near the point of greatest consumption. Properly constructed, the insulation of an entire system of this kind should be very high, sometimes reaching in actual practice to hundreds of thousands of ohms. Service tubes may be connected at any of the joints between the 20ft. lengths, as at A. Here the size of the building to be lighted makes it advisable to carry the three-wire system through the edifice, dividing perhaps on each floor, or for each main department. In the cases of theatres, churches, rinks, and other public places this plan is especially desirable, as the size of inside wire may be reduced, and by intergroup compensation the important feature of a perfect balance on each main is assured.

The three-wire plan, as thus far elaborated, illustrates very forcibly the advantage of a system connected as a single network of conductors over that of radiating lines. If a main be broken at any point so that the supply of current from the nearest feeder is cut off, it is still charged from the other direction.

As Mr. Edison has graphically expressed it, "the current comes around the corner from the next block, and the lights still burn." If a feeder be disabled from any cause, the fusible strips are removed at the station, those by which it is connected with the system at the catch box on the street are taken out, and it can be readily repaired

feeders, in their construction, to slightly vary their conductivity from time to time by means of resistance-boxes known as "equalisers," introduced into their circuits at the station.

Now, if in consequence of a large consumption of light in the neighbourhood of A, Fig. 21, the pressure drops at boxes 1 and 2, a little resistance on feeders 3 and 4 enables us to raise the pressure at the station, and send sufficient current through the weakened channels to restore the equilibrium. The same result can be secured with a saving in current by making the mains large and the drop in feeders of less consequence. That this variation of potential at the ends of the feeders may be known and regulated, each feeder tube is supplied with three small wires connected with the system at the junction-box which forms the feeder terminus, and acting as a return circuit to the station, where a voltmeter or indicator of peculiar construction is attached on each side. This arrangement appears in the diagram, Fig. 22, illustrative of central station connections.

The feeder principle of distribution, by which the central station is scattered about, as it were, to all the junction-boxes, and from these points delivers current of proper pressure, is entirely original with Mr. Edison. The methods of the gas companies, which were closely followed

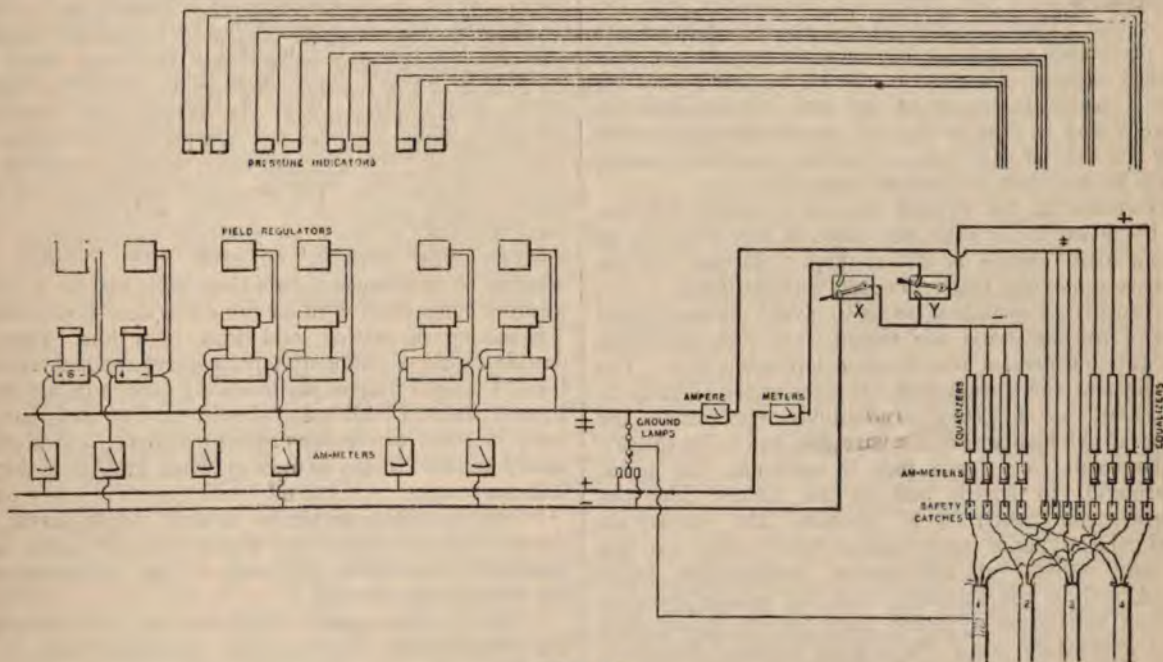


FIG. 22.

while the remaining feeders supply the mains. The lamps illuminating the central station are taken from the mains instead of directly from the bus bars, that their action may be noted by the operator in charge, as an indication of the working of those outside; and, also, because with any considerable load the drop in potential between the station and the lamps on the street, occurring in consequence of the resistance of feeders and mains, obliges the maintaining of a comparatively high E.M.F. at the dynamos which would speedily destroy lamps of the resistance, or, as technically known, of the "volt," used by consumers.

Right here we encounter one of the cardinal difficulties of distribution for incandescent work—that of equalising through the system the drop in potential occurring whenever its full capacity is approached. To secure practically perfect results, the resistance of all the feeders and mains must be so proportioned and regulated that, however the resistance of any point or section of the lamp circuit may vary, the current shall maintain a nearly uniform pressure in all the ramifications of mains and inside wiring of buildings, and each lamp give the same light as every other. An exact regulation is practically impossible, but we may far exceed the best results in water or gas pressure in our approach to the ideal conditions. It is only necessary in addition to a proper calculation of the resistance of each of the several

so far as they were adaptable to the government of the more potent agent which we utilise, did not at the time of application for the feeder patents (No. 264,642, issued Sept. 19, 1882, and No. 266,793, issued Oct. 31, 1882) include any analogous means of equalising pressures. Since the experience of the Edison stations has demonstrated the usefulness of the idea, gas engineers have applied it to several of the most comprehensive systems now operated, and with marked improvement, as might be expected.

By these methods and devices, in connection with mains, and house wiring so calculated as to avoid the heating of small wires by attaching too many lamps, and raising the candle-power in other localities by reason of excessive conducting capacity, the regulation is effected with such nicety that there is no perceptible difference in the brilliancy of lamps throughout the system.

A little reflection will show the fallacy of the effort so often made in central station work to establish an automatic regulation of pressures by compound-wound dynamos. We can attain to such a perfection of manufacture as to make a dynamo which can be guaranteed to give a potential varying at the brushes to a sufficient degree to make up for the loss in a feeder line; but we are still powerless to compensate by that means for a greater loss in one feeder than in another. Hence, in systems of any

magnitude, and practically in all systems supplied by more than one feeder, it has been found essential, not only in the interests of simplicity, but of reliability, to depend upon hand regulation and the careful oversight of intelligent inspection.

DYNAMOS IN MULTIPLE ARC.

Perhaps there is no one point more forcibly illustrative of the adaptability of the Edison methods to the constantly varying requirements of central station work than the readiness with which the dynamos may be connected to work together, like spans of draught animals, each adding its measure of efficiency to the power of the others to produce a common result. As early as 1883, at the Louisville Exposition, 16 450-light machines were so arranged, and in the first New York station the six mammoth dynamos, capable of carrying 2,000 10-candle lamps each, have been since 1882 manipulated in precisely similar manner, the only care needed being to keep their E.M.F. equal, that the load may be well divided, and that no opportunity may be given those yielding normal current, to short-circuit by over-balancing the reduced force of any other, and pouring their current through its armature. In practice this is perfectly easy. The exact conditions in the case of the three-wire arrangement may be understood by Fig. 22, which also shows the general method of connecting the generators with the regulating mechanism and the feeder system. Here are shown two dynamos of small size belted preferably direct to the two driving-wheels of a high-speed engine. This pair of machines is very valuable in a small station, inasmuch as the early evening and late night work may be done with much greater steam economy than by the heavier dynamos. The field regulator connections will be perfectly understood from this view.

Any dynamo in the system may be so connected at a moment's notice as to take the place of any other, as in practice a spare engine is always kept "warmed up," its piston barely moving, ready to speed without delay.

The process of switching so as to avoid flickering and flashing of the lamps on the circuit was, in the early history of the business, a somewhat complicated one. The ruling spirit of the station took his place at the regulators, his assistant at a group of switches controlling the dynamos. If the load was on the increase, and to be thrown from the small to a large pair of machines, the latter were brought to speed, and as he turned out the resistance from their field circuits, the electrician watched the dynamo pilot lamps until those on the heavy pair arrived at the proper comparative brilliancy. A nod to the assistant, and the proper switches controlling the larger dynamos were thrown in, and both pairs of generators were working in unison. Carefully turning out resistance in the fields of the incoming dynamos, and at the same time weakening those to be relieved, the load was quickly shifted, and at another signal the switches of the small dynamos were opened, the full resistance thrown into the circuit of their field-coils, their magnets almost instantly lost all their power, and the engine was stopped at leisure. Later apparatus furnishes individual ampere-meters and comparative voltmeters, by which these changes are very rapidly made without any flickering whatever.

OTHER STATION DETAILS.

The neutral wire is usually designated by the character $\pm$, a combination of the positive and negative signs.

Just outside the ampere-meters on the positive and neutral omnibus wires (corresponding to the holder in a gas system so far as to be the centre from which distribution is effected), are two heavy switches, X and Y, by which the positive or negative of a small station carrying a light load may be cut at will. Suppose that while carrying only a medium number of lamps, dynamo No. 3 suddenly gives out. Throwing the lever of switch Y downward, the circuit of the useless machine is instantly opened, and with barely a flicker the load is saddled upon its companion, which now supplies both sides of the circuit, the neutral wire becoming positive to both the others. In such a case, which is very unusual, but possible, the E.M.F. is reduced to 110 volts, and the number of lamps which can be kept at candle-power depends upon the

carrying capacity of the middle wire of the system, which must supply all the current used. Under these conditions, it is interesting to notice that two lamps connected in series between the positive and negative would go out, or motors so connected would stop, these outside wires now being of the same polarity. The "omnibus" wires here divide, and the positives and negatives of the individual feeders pass through the equalisers, and also heavy plug switches and the station safety catches, and by flexible cables join the feeder conductors. The small pressure wires issuing from the tubes are connected with those above the omnibus wires, and lead to the volt indicators.

The presence of a ground on the system is instantly shown by a group of four lamps permanently connected to earth and to the middle wire, and so adjusted by a plug switch as to be readily attached to either positive or negative in the manner indicated. The phases of their operation are very difficult to describe, but will be understood by an electrician. They give something like 25 different indications, and are very valuable as a tell-tale, showing any variations in the practical insulation of the system.

WIRING OF BUILDINGS.

The matter of wiring buildings for the three-wire system has been a subject of special study by the Edison Company. Early in the business any installation of 50 lights or less was attached to one side alone, overlooking the fact that in traversing the neutral wire for a considerable distance to another building a drop occurred, which was likely to materially decrease the candle-power of both groups of lamps fed by a given number of amperes. Now in the best practice we divide the lamps of a group of six or more in any one building between the two sides, and secure a close approach to perfect distribution, the effect being not only to reach an accurate *total* balance, but an accurate *local* division on each main. Hence, wiring adapted to be connected to a three-wire service is essential where a connection with an Edison system is expected.

Speaking of wiring, and that twin idea which to a practical man is immediately suggested—namely, inspection—I trust I may be pardoned if I quote a paragraph from a paper which I read before the Society of Arts in Boston early in 1885, which has proved prophetic, and is unfortunately as true to-day as it was when first read, more than four years ago:

"The important matter of careful inspection of incandescent light apparatus and wiring does not seem to have heretofore received at the hands of the insurance officials the attention it deserves.

"The gravest aspect of the case lies in the fact that, as the incandescent system gains popularity and its great advantages become really appreciated, new business blocks, public edifices, fine residences, in fact, multitudes of structures, will be wired during construction, and the work, good, bad, or indifferent, rapidly covered, preventing adequate inspection, except as the result of persistent and painstaking scrutiny.

"With the growth of the general industry new firms and individuals will enter the field as wiring agents, and many who have done electric bell, speaking tube, burglar alarm, and kindred work will fancy or assume that with the cheap material or labour upon which numbers of them rely as their principal stock in trade, and some smatterings of book-lore as to harmless battery currents, they are abundantly equipped for business without the special experience regarding insulation, computing size of conductors and the proper distribution of light which are recognised to be indispensable to safe and successful wiring. One of two things will then happen; the public will be disappointed, whenever such people are employed, in finding themselves unable to use the wires and fixtures for which they have paid, or stand in imminent danger of having their edifices burn over their heads. This is not an imaginary picture. Some of the Boston inspectors know that instances already exist, almost within a stone's throw of this spot, where such wiring has been done by inexperienced parties, whose misrepresentations have victimised those who have employed them, though perhaps in many instances the truth has not yet appeared. In some cases, however, the attention of the underwriters has

been called to the matter in time to apply the remedy without the great inconvenience or expense of tearing up carpets, cutting floors, and defacing ornamented walls and ceilings. The moral is obvious."

RELIABILITY OF THE DYNAMO.

The Edison dynamo, powerful as it is for the production of currents of tremendous heating energy, contains within itself the elements of safety in extreme cases. If the main conductors come by any chance into metallic contact, or are suddenly connected by carbonised material of high conductivity, the external resistance is so quickly reduced that before either a destructive arcing can take place or the armature itself become seriously heated, the current will forsake the circuit of the field-magnets, and their strength will instantly fall below the power to generate further dangerous force. It is a fact, therefore, that the large Edison machines, and perhaps all sizes of the latest construction, are of such low resistance as to be practically indestructible by short-circuiting, except by an accident when running in multiple arc with others. Even then a suitable safety catch will melt and prevent damage.

CONSERVATION OF ENERGY.

In this system, successful because commercially applicable to the needs of society, we may find a beautiful illustration of that most sublime of scientific facts, the imperishability of energy, and also of that other interesting and vital principle, the ready transformation of Nature's forces from one form to another. We may note here successive examples of the losses attending every change, leading us up to that crowning conclusion, the unity of all these forces or manifestations as a single, all-pervading, all-controlling energy called into being by an Omnipotent Author, by means of which He has brought order and beauty from chaos, and responsive to which every atom of the universe (boundless to our fettered sensibilities) quivers and vibrates and oscillates in perpetual obedience.

You enjoy in your library the incandescent lamp, the rays of which are concentrated without perceptible heat upon your paper as you write or read. Did you ever stop to enquire how many transformations of energy were necessary to furnish that light for your convenience, or what losses were incurred in these changes?

Thousands, perhaps millions, of years ago, before man's appreciative intelligence was evolved through the wonder-working of the Creator's slow but sure design, a mass of matter wandering through the infinity of space, was attracted by the gravity of our central sun. As it plunged into his fiery atmosphere the energy of the motion into which the force of gravity was transformed, was converted into heat, and additional energy in the form of chemical action as the mass burned intensified this heat and transformed it into light which sped to our little world, fell upon forests of marvellous luxuriance, changed in a twinkling again to chemical affinity, and was stored away in the wood, changed as the ages rolled by to coal. Here it lay idle and inert, until now in the fulness of time man digs it up and throws it under the boiler. Again, the wonderful attraction for oxygen, so long latent, instantly asserts itself. It flashes into flame, its energy rapidly changes to heat, then to expansive force of steam, then to motion in the cylinder, belt, and armature, then to magnetism and to its twin sister electricity, flies along the conductor, and in a trice its desperate effort to pass the delicate bridge of the carbon filament is arrested, and its impetus is transformed into heat and light once more.

Thus far we can follow the losses we have sustained in our effort to use Nature's stored energy. We are, at best, able to save in the steam produced about 70 per cent. of the heat units which were originally laid away in the coal which we to-day place upon the grates. Allowing that 16 per cent. of this steam energy is lost in condensation and friction in the pipes, we encounter in the engine the enormous loss of 83 per cent. of the remainder, and hence we find delivered to the dynamos by the belt only 10 per cent. of the original power. This dynamo, as a marvellous transformer of one form of energy to another, stands alone. In our central station work we expect, after

allowing for all the losses by friction, resistance of armature conductors, Foucault currents in the core, and the portion expended in vitalising the field and in its regulator resistance, the retardation of the air and other hindrances, to get back about 93 per cent. of the energy with which we feed it. Hence, we probably realise in electricity 9.3, or less than 10 per cent. of the heat units in the coal. Then we lose, say, 10 per cent. more in conductors, and, lastly, we find the incandescent lamp can convert for us into light only about 5 per cent. of the watts brought to its terminals, including, of course, the loss in the best pot glass bulbs. The effect produced in a room by an ordinary 16-c.p. lamp, therefore, represents in actual energy radiated as light about 0.18 foot-pound per second, or a power sufficient to lift one-fifth of a pound one foot high (against the force of gravity) in one second. It has taken, however, an expenditure of 200 times this energy, or 40 foot-pounds per second in heat units at the coal pile, to make this result possible. What interests the central station manager is that his receipts are only reckoned on the one-fifth of a foot-pound.

But another series of marvellous transformations remain. The light falls upon our paper and is reflected to the eye. Traversing the crystalline structure it strikes upon the sensitive retina, is metamorphosed into heat, then nervous force (perhaps electricity), and speeding along the conductors, which are the telegraph lines to the seat of life, the impulses of this delicate current disturb the sensitive matter of the brain, and by the arrested motion or heat of their impact convey to the ever-watchful operator, the soul, the messages coming from the material world outside.

Have you ever thought that this coal is the greatest of the storage batteries from which we can draw the little supply we borrow from Nature's vast laboratory? We try to imitate the operation of the elements in treasuring up force only to find how meagre our powers are.

It is only when we can reduce the first cost of the power we expend by taking advantage of this perpetual storage by Nature that we can afford to supply ourselves with an apparatus necessary to bridge over any temporary failure, either of the supply of water, transforming or distributing machinery. If we attempt to avoid the necessity of a constant action of our dynamos by a system of accumulators, we complicate an expensive process still further by introducing two more chemical transformations, and so reducing by from 20 to 50 per cent., according to circumstances, the electrical energy furnished by our generators, and are compelled to buy expensive apparatus, expensive not only because of its first cost, but its invariable, and often rapid, depreciation. Thus, as over vast stretches of the earth's surface water powers are entirely lacking and windmills cannot be depended upon, until Mr. Edison's dream of the economical production of electric light currents directly from coal can be realised, we are restricted in the uses to which we can apply stored electricity. These uses, however, much restricted though they may be, are often of the first importance, and the actions which take place are among the most interesting which we meet in the whole practice of electrical science.

The action of the current on the battery plates tears apart or dissociates the chemical elements, which are then held at arm's length by the energy poured through them, or the stress produced by the passage of the current, but whichever tend to recombine as quickly as the removal of the disruptive energy, or the closing of a circuit forms a path for the flow of the electric current into which the chemical affinity is retransformed. Even in our most successful efforts we find it uneconomical to use batteries for incandescent lighting, for the running of street cars, or for other purposes, to store more than a quantity to run our lamps for an evening of five or six hours, or our railway motors for more than a part of a day's work. The Edison Company has now for the first time ordered accumulators for a small station, and proposes to test their practical value in enabling it to supply light and power from midnight till morning. The gas companies are similarly unable, in transforming the latent heat units of the coal into the invisible fluid by which they distribute light, to store more than a limited

supply day by day. The accumulators of the hydraulic engineer do not store even one hour's supply, and compressed air receivers have about the same capacity.

The most feasible method yet found for storing mechanical power on a large scale is by the reservoir of water. How large this must be, few of us have probably reflected. If you allow to a turbine wheel an efficiency of 75 per cent. it will require one acre of water one foot deep to supply even 1 h.p. for one hour for one foot of fall. Thus it has been through ignorance of the real facts that many people have lifted up their voice against the methods which we are compelled to pursue in generating electricity only as fast as we can use it for all the manifold necessities and conveniences of modern society. It has been forgotten that we have no means of putting into stock any form of force, and that, practically, energy must be produced as it is wanted.

Again, we have not learned to absolutely control such storage cells as we can produce, and we are daily learning the terrible hazard of confined forces, whether naturally or artificially massed. In man's toying with the electric spark one of the first things was the transformation of the energy of motion into frictional heat and electrical stress. The Leyden jar stores this volatile energy for a short time—then expends in a thousandth or a millionth of a second what has been minutes in accumulating. In other words, the rate of doing work is so greatly accelerated in the discharge that there comes a time when, no matter what the medium through which the difference of pressure is equalised, it is not able in its normal condition to transmit the flow rapidly enough, and is disrupted or broken through.

We find that this swift, potent, and flexible agent, in its milder, or we may say slower, manifestations shows no signs of a troublesome inertia, even when we force it to turn sharp corners so quickly that thought fails to follow it. But if we attempt to force a vast energy through even a good conductor in an infinitely short time the material itself shows its inertia by blocking the path of the discharge and causing it to fly aside. This points to the idea that our measurements of electrical pressure are really measurements of electrical velocities, and that for all the purposes of our practical work, and so far as we know, absolutely, the speed with which electric action takes place is measured by what we call its potential, or power to do work, with the pressure which is the resultant.

So the silent power of the sunlight expended as heat on vast bodies of water raises a percentage of their mass to vast heights, and sudden condensation changes the energy thus stored to electricity. The accumulated charge is confined by the suspended moisture above a stratum of insulating air at the surface until its potential, far above anything man's puny apparatus can produce, bursts the bonds of the air, and in a fraction of a second the imprisoned might accumulated during many hours is expended upon the forest tree. Its resistance impedes the rushing thunderbolt, and the energy of arrested motion is transformed to heat, turning to superheated steam every drop of sap in an interval of time so small that the human mind cannot measure it, bursting every moisture channel as if filled with dynamite, and scattering the toughest tree in splinters on every side. Here is energy expended in a contracted area at the rate of millions of foot-pounds per minute.

We build high walls to store the energy of falling water in reservoirs. For days and weeks and months the potent forces of the sky quietly raise it from the rivers, the lakes and the ocean, and deposit it gently in our frail storage vessel. There we hold it against the force of gravity, its depths as tranquil as the mountain side which is reflected on its bosom, until our feeble barrier crumbles and suddenly breaks, and all the energy which has slowly and silently accumulated is expended in a single hour, with a crash like that of rending worlds before the fabled blast of indignation from an offended Deity, destroying in its resistless rush the cities, the homes, and the lives of men.

It is unscientific as well as foolish and irreverent to preach of judgments upon us and mysterious dispensations of Providence in cases like this. We are but learning how to bring to our service more completely the grand forces of

the earth and sea and air, though sometimes our shortsightedness brings us suffering and dismay and loss ere we grasp the lesson.

Perhaps no thought can be more profitably emphasised and carried away with us than this underlying principle of all our work. No energy is ever destroyed. It is depleted by transformations, but the portion which we fail to recover has simply changed its form, and been distributed or dissipated beyond our reach as heat.

Let us point one of the great telescopes of our observatories toward a spot in the midnight heavens, which to our natural vision is a blank. Its giant eye gathers in and focalises rays too faint for unaided human sight to catch, and we are in effect transported in an instant hundreds of millions of miles. Far away in the regions of immensity, deeply sunk in the depths of space, we dimly discern a light, hazy cloud. Apply a higher power and this cloud brightens and separates into distinct stars. The ray of light which sparkles upon the retina of our eye left that glittering sun before the dawn of human history.

During the dim ages of the past it rushed on at the rate of more than 17,000,000,000 miles every day through the shadows of infinite space. The Sphinx and the pyramids have been reared from the sands of the Nile long since its flight was well begun. Nations have risen, flourished, died, but it has stopped not, it has loitered not, it has shot onward in its terrific speed, and when it has finished its journey, its energy, lessened by what we call the losses in dissipation through the limitless areas of the heavens, is expended upon our sensitive photographic plate, instantly transformed into chemical action, and we have a fadeless image of the source from whence it came.

LEGAL INTELLIGENCE.

POSTMASTER-GENERAL v. GREAT WESTERN RAILWAY.

This was an appeal before the Lord Chancellor, Lord Herschell, Lord FitzGerald, and Lord Macnaghten, by the Postmaster-General from an order of the Court of Appeal, dated May 8, 1888, reversing a judgment of the Queen's Bench Division upon a special case stated for the opinion of the Court in the matter of a petition of right wherein the respondents were the suppliants, praying for a declaration as to the construction and effect of an agreement made on July 9, 1868, between the Postmaster-General and the railway company and confirmed by the Telegraph Act, 1868.

The Solicitor-General and Mr. S. W. Casserley appeared for the appellants, and Sir H. James, Q.C., and Mr. R. S. Wright for the respondents.

It appeared that by the agreement in question it was provided that, upon the acquisition by the Postmaster-General of the undertakings of any of the telegraph companies with which the railway company had agreements, the wires, poles, and other apparatus should become the property of the railway company, who should thereafter maintain and work the apparatus. Certain other poles, wires, and apparatus became the property of the Postmaster-General. The Postmaster-General had power to use all the wires and to erect new poles if necessary, and to require the railway company to affix additional wires to these poles, and the cost of maintenance and renewal of such poles were to be borne by the Postmaster-General and the railway company in proportion to the number of wires belonging to each respectively on each pole. It was further agreed that the railway company might shift the poles, wires, and apparatus of the Postmaster-General when necessary for the purposes of their traffic, but in all such cases the Postmaster-General should pay to the company the actual costs incurred in shifting such poles and apparatus, but if such poles supported the wires of the Postmaster-General and of the railway company, the cost of shifting should be apportioned according to the number of wires respectively used by each. Since 1878 the Postmaster-General had refused to pay any cost incurred in shifting poles belonging to the railway company, although such poles support wires of the Postmaster-General as well as those of the railway company. The company consequently instituted these proceedings, and contended that whether the poles belonged to the Postmaster-General or the company, the cost of shifting should be apportioned in proportion to the wires owned by each. The Divisional Court decided against the railway company's contention. The Court of Appeal (Lord Justice Lopes dissenting) held that the railway company, if the poles belonged to them, must pay the cost of shifting the poles, and then that the Postmaster-General and the railway company must each pay the cost of shifting their respective wires.

Their Lordships now gave judgment dismissing the appeal.

The Lord Chancellor: My lords, it is necessary, I think, in this case to consider carefully the history of the contract as disclosed by its own provisions, and the nomenclature which the parties have adopted to express their meaning. Now, it appears that at the time when the agreement in question was entered into the Great Western Railway Company had various agreements with the Electric Telegraph Company in respect of its own line

proper, and also in respect of lines, or parts of lines, which had become absorbed in or formed part of the system. The 21st section of the agreement shows that a Bill was then (on June 9, 1868) before Parliament. I think one may assume that the Bill in question became on July 31 following the Telegraph Act, since by the 13th section of that Act the agreement, which is the first in the schedule, is confirmed subject to the provisions of the Telegraph Act itself. The 4th, 5th, and 6th divisions of the contract show that at the time it was entered into the railway had a telegraphic system of its own, which it was intended to preserve to the railway for railway telegraphic purposes, and that there were alongside, and forming part of the railway system, poles and wires used for the purpose of public messages. If any of these were used exclusively for public messages (as to which, strangely enough, the parties appear to have been in doubt), the bargain was that, upon the acquisition which both parties contemplated as approaching, such poles and wires were to become the property of the Postmaster-General. But in any event it was clear that after the acquisition the parties contemplated that two separate telegraphic systems should exist concurrently, the railway telegraph being restricted in the use of their telegraph to railway purposes, the Postmaster-General, of course, carrying on the commercial undertaking of transmitting messages for reward. In this condition of things it appears to have occurred to both parties that each might want to use the posts belonging to the other for the purpose of carrying on their respective telegraphic operations, and, accordingly, reciprocal rights are given by the agreement to the railway under the Postmaster-General. The wires belonging to the old telegraph company and exclusively used in the transmission of public messages were, or some of them were, erected on poles, which, under the agreement, were to be handed over to the railway company. These wires, together with other wires not on the lines of railway at all, the Postmaster-General was to be entitled to use; and further, if the railway company's poles were sufficiently strong and high for the purpose, the Postmaster-General was to be entitled to call upon the railway company to erect and maintain on their poles additional wires and to erect new poles, provided no obstruction to the convenience or working of the business of the railway company should be caused thereby. The railway company were to maintain all the poles and wires used for public messages, the Postmaster-General paying for erection and maintenance. Then, each party was to have the right to call upon the other, under the same reservation as before as to the strength and height of the poles, to affix wires to the poles of the other, and the cost of the maintenance and renewal of such poles of the railway company and the Postmaster-General were to be paid by the Postmaster-General and the railway company in proportion to the number of wires belonging to each. It is in following out this part of the agreement that we come to the ninth clause of it, which raises the question that your lordships have to determine. The first contingency contemplated by the contracting parties was the possibility that the poles, wires, and apparatus might in the course of time interfere with the free exercise of the railway company's proprietary rights in the management or extension of their works or traffic. And they then provide that in all such cases—that is to say, in all cases in which the railway company may find it necessary to shift the poles, wires, and apparatus belonging to the Postmaster-General—they should be at liberty to do so; and inasmuch as the necessity for the shifting was for the purposes of the railway company's works or traffic—the independent right to manage which they did not mean to render subject to the Postmaster-General's convenience or profit—they stipulated that the actual costs incurred in shifting such poles and apparatus should be paid by the Postmaster-General. Now, it is to be observed that the poles might belong to the Postmaster-General, and that wires and necessary insulators belonging to the railway company might be fixed upon them, and some poles might have wires and insulators belonging to both the parties. And it is under such a contemplation of such divided property that the provision is inserted which has given rise to the contest between the parties. The first word in the provision which it is necessary to construe, is the word "such" in relation to the first two lines of the ninth clause. If the words "poles, wires, and apparatus belonging to the Postmaster-General" are not to be taken distributively, then the word "such" must mean to refer to poles, wires, and apparatus, all three in combination, belonging to the Postmaster-General. But it seems to me it would be very unreasonable to suppose that the parties forgot such a very obvious contingency as the possible necessity of moving wires and apparatus, insulators, for instance, when it might not be necessary to move the poles at all. But if one reads the 9th clause distributively, the railway company might shift the poles if necessary, the wires if necessary, and the apparatus if necessary, although only one of these things should be moved, in which case the use of the words "such poles and apparatus" would mean such shifted poles, such shifted wires, such shifted apparatus as, under the powers of the 9th section, in fact were shifted. But the further difficulty in construction arises from the fact that the draughtsman in the power to shift has used the words "poles, wires, and apparatus"; but in referring to the cost has used the words "the actual costs incurred in shifting such poles and apparatus," and unless the word "apparatus" includes wires it is impossible to say that the case that has actually arisen has been provided for by the agreement. Undoubtedly, in the earlier parts of the agreement wires were expressly mentioned as telegraphic apparatus; but the difficulty here arises from the fact that in the beginning of the 9th section wires are apparently separated and distinguished from apparatus. In the words under construction the word "wires" is omitted; nevertheless, the context seems to show that if in the shifting such poles and apparatus cost was incurred, both parties were agreed that that cost should be provided for in the arrangement that was being made. Now, one construction of the contract undoubtedly leaves such cost unprovided for, and the

great difficulty which has been present to my mind has been the fear lest we were not ourselves making a term of the contract (necessary and reasonable, undoubtedly), which, nevertheless, the parties had not made for themselves. But as the very matter of the proportion of cost which each party was to bear was undoubtedly present to their minds, it would be unreasonable to suppose that the parties had, either intentionally or inadvertently, left uncovered by the agreement one of the ordinary cases which the whole scope of the agreement rendered almost certain to occur. If one supposes that the words "poles, wires, and apparatus" are to be read distributively it is almost impossible but that the parties must have intended in providing for the division of the cost to have made such division bear some relation to the power which they had just agreed upon. If one supposes that the word "apparatus" was used as a compendious phrase for what had been previously dealt with, the meaning of the clause becomes clear, and where the context so obviously requires it I do not think that violence is done to the language in construing the word "apparatus" to include "wires," inasmuch as that word, as I have already pointed out, has been used by the parties themselves in the same instrument as including "wires." I cannot say that I am much influenced by the phrase "in all such cases." These words would be aptly used in that context whether the agreement was dealing with each occasion of removal of all the things in combination. Upon the whole, therefore, I agree with the Court of Appeal, and move your Lordships that this appeal be dismissed with costs.

The other noble and learned lords having concurred, the appeal was dismissed with costs.

COMPANIES' MEETINGS.

UNITED RIVER PLATE TELEPHONE COMPANY.

The third annual ordinary general meeting of the United River Plate Telephone Company, Limited, was held on Thursday, the 8th inst., at Winchester House, E.C.

The **Right Hon. Lord Thurlow** (chairman) presided, and in proposing the adoption of the report said the balance-sheet was highly satisfactory, with one solitary exception, that was the loss on exchange. The rates had been unprecedentedly high, and of long continuance, absolutely absorbing 5 per cent. of the subscribed capital. The report issued last year represented 16 months, and for that time they paid 7 per cent. for the 16 months, which was equal to 5½ per cent. for 12 months, so that on the present occasion, in offering 6 per cent., they were giving them ½ per cent. more than for the corresponding 12 months. Therefore, notwithstanding the difference in exchange, etc., they had actually done better than last year. The Company commenced with 3,150 subscribers in and around Buenos Ayres, and that number had now been increased by rather more than 50 per cent.

Mr. J. Irving Courtenay seconded the motion, which was carried unanimously.

Mr. A. le Rossignol, who had lately returned from Buenos Ayres, said he found that during his absence the town had increased fully 50 per cent., and the telephone was made more use of there than in England.

Mr. Jones was re-elected director; his colleague, **Mr. Lloyd**, did not seek re-election; **Major Henry Fitzgerald** had also resigned; but the Board did not propose to fill these vacancies. Consequently the Board would be reduced to the original number of seven, which had been contemplated for some time.

The Auditors were re-elected, and the usual vote of thanks closed the meeting.

NEW COMPANIES REGISTERED.

Brush Electrical Engineering Company, Limited.—Registered by Renshaws, 2, Suffolk-lane, E.C., with a capital of £750,000, in 150,000 preference shares of £2 and 150,000 ordinary shares of £3 each. Object: to acquire by transfer (for the purpose of reconstituting the Anglo-American Brush Electric Light Corporation, Limited) the undertaking and business heretofore carried on by the Anglo-American Brush Electric Light Corporation, Limited, in the United Kingdom and elsewhere, and also the letters patent and patent rights, and the lands, buildings and other hereditaments, works and conveniences, and fixed and movable plant held, occupied and used by the Anglo-American Brush Electric Light Corporation, Limited, and stock-in-trade and effects and all other the property of the corporation; and to undertake and satisfy the contracts and any portion of the liabilities and obligations of the corporation which may not be satisfied by the corporation or the liquidators thereof; and with a view to such reconstitution to enter into an agreement to be made between the Anglo-American Brush Electric Light Corporation, Limited, and J. B. Braithwaite, jun., and Emil Garcke, the proposed liquidators of such corporation, of the one part, and this company of the other part, and to carry the same into effect; to continue the business, and further to acquire the undertaking and business of the Falcon Engine and Car Works, Limited, heretofore carried on by the company at Loughborough, and the stock-in-trade, effects and other property of that company, and with a view thereto to adopt an agreement dated July 12, made between the Falcon Engine and Car Works, Limited, of the one part, and Bertrand Broadhurst, as trustee for this company, of the other part, to carry the same into effect; to carry on the businesses of electricians,

mechanical engineers and manufacturers of any kind of electrical apparatus and appliances, and workers and dealers in the same. The first subscribers are:

	Shares.	Ord.	Pref.
Lord Thurlow, 33, Chesham-place, S.W.	1	...	1
J. S. Sellon, 78, Hatton-garden	1	...	1
E. Gareke, 112, Belvedere-road, Lambeth, S.E.	1	...	1
Col. F. G. Stewart, 16, St. James'-square, S.W.	1	...	1
E. Cooper, 14, George-street, Mansion House, E.C.	1	...	1
E. Woods, 45, Onslow-gardens, S.W.	1	...	1
J. Raworth, 112, Belvedere-road, Lambeth	1	...	1

There shall not be less than five nor more than nine Directors. The first are the Right Hon. Lord Thurlow, J. S. Sellon, Colonel F. G. Stewart, E. Woods, J. B. Braithwaite, jun., the Duke of Marlborough, and A. H. Sanderson. Qualification, £500. Remuneration, £2,000, divisible. When in any year the dividend, with bonus, if any, on the ordinary shares shall amount to more than 10 per cent. on the capital for the time being called up, the Directors shall be entitled to an additional sum equal to one-tenth of the amount of such dividend, provided that such additional sum shall not exceed in any year £10,000.

Column Printing Telegraph Syndicate, Limited.—Registered by Rollit and Sons, 12, Mark-lane, E.C., with a capital of £10,000 in £50 shares. Object: to acquire certain patents and rights in relation to printing telegraph machines, and with a view thereto to adopt an agreement, dated August 1, made between J. Moore and J. E. Wright of the one part, and J. E. Cockett, on behalf of the syndicate, of the other part. Most of the regulations of Table A apply.

CITY NOTES.

West Coast of America Telegraph Company.—The receipts for the month of July amounted to £5,350.

Brazilian Submarine Telegraph Company.—The receipts for the week ended August 9 amounted to £5,176.

Direct Spanish Telegraph Company.—The estimated receipts of this Company for July were £1,677, against £1,518.

Great Northern Telegraph Company.—The receipts of this Company for July were £24,800, making from January 1 a total of £154,200.

Eastern Extension Telegraph Company, Limited.—This Company's receipts for the month of July were £42,876, as against £35,233 for the same period of 1888.

Cuba Submarine Telegraph Company.—The receipts of this Company for July were £3,000, against £3,086. The receipts for April, estimated at £4,000, realised £4,060.

Western and Brazilian Telegraph Company, Limited.—The traffic receipts for the week ended August 9, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,631.

West India and Panama Telegraph Company.—The estimated receipts of this Company for the half-month ended July 31 are £2,690, as compared with £2,857 in the corresponding period of 1888. The April receipts, estimated at £7,142, realised £7,144.

Companies of the Month.—The following electrical companies were registered during the past week:

	Capital.
Henley Telegraph and Electric Construction Company	£200,000
Peru Telephone Company	100,000
Ecuador Telephone Company	100,000
Westinghouse Electric Company	600,000
Woodhouse and Rawson, United	350,000
General Electric Company	60,000

Fowler-Waring Cables Company.—This Company has been formed, with a capital of £200,000 in 40,000 shares of £5 each, to acquire and unite the electric cables business now carried on by John Fowler and Co. (Leeds), Limited, and by Mr. Richard Waring, at 85, Queen-street, London, and to acquire and work the patents taken out for the United Kingdom by Mr. James Tatham, of Philadelphia, U.S.A., and by Mr. R. W. Eddison, of the Steam Plough Works, Leeds, and by Mr. R. S. Warring, of Pittsburgh, U.S.A., for improvements in the manufacture and insulation of metal-covered electrical cables. Full particulars will be found in our advertisement columns.

PROVISIONAL PATENTS, 1889.

AUGUST 6.

- 12374, **Improvements in magnets.** James Frederick Bennett, 136, Cemetery-road, Sheffield, Yorkshire.
- 12378, **Electric drills.** Imle E. Storey, 70, Market-street, Manchester. (Complete specification.)
- 12389, **An electrical contact maker and current diminisher for train lighting purposes.** Edward John Houghton, Camden, Underhill-road, Dulwich.

12390, **Improvements in electric motors.** Stanley Charles Cuthbert Currie, 6, Livery-street, Birmingham. (Complete specification.)

12418, **Improvements in or relating to the manufacture of insulating tubing for electric conducting wires.** Alfred Julius Boulton, 323, High Holborn, Middlesex. (Henry B. Cobb, United States.) (Complete specification.)

12436, **Improvements in magnetic electric machines.** Henry Julius Smith, 77, Chancery-lane, London. (Complete specification.)

12437, **Improvements in electric drinking vessels.** Frederick William Flint, 77, Chancery-lane, London. (Complete specification.)

12444, **Improvements in switch boards for telephone systems.** John Randolph Smith, 53, Chancery-lane, London.

12474, **The inlaying of metals by electro deposition.** Howard William Bishop and Frederick Brown, 16, Bridge-street, Walsall.

12503, **Improvements in dynamo-electric machines.** Frederick Vilhelm Andersen, 156, Strand, London.

12518, **Improvements in incandescent electric lamps.** Theophilus Coad, 1, Quality-court, Chancery-lane.

AUGUST 8.

12552, **A novel construction or arrangement of electro motor.** James Hewitt Barry and Gilbert Betteley Lückhoff, 166, Fleet-street, London.

12563, **Improvements in electrical ships' logs or means for ascertaining by electricity the speed of ships.** Robert Mann Lowne, 23, Southampton-buildings, London.

AUGUST 9.

12569, **Improvements in plates for electrical transformers.** Reginald Belfield, 6, Lord-street, Liverpool.

12615, **Improvements in and relating to dynamo-electric machines or motors.** Francis Jarvis Patten, 45, Southampton-buildings, London. (Complete specification.)

AUGUST 10.

12647, **Improvements in alternate current dynamos.** Guy Carey Fricker, 39, Montserrat-road, Putney.

12659, **Improvements in or relating to mechanical telephones.** Thomas Beavan Sloper, 323, High Holborn, London.

SPECIFICATIONS PUBLISHED.

1888.

- 10437, **Printing telegraphs.** Wright and Moore. 11d.
- 10900, **Electric alarm for varying levels.** Siegmunn. 6d.
- 13402, **Secondary batteries.** Varley. 8d.
- 13615, **Electrical batteries.** Satterlee. 8d.
- 13621, **Electric meters.** De Ferranti. 8d.
- 13717, **Electric batteries.** Elosser. 8d.
- 17123, **Electrically regulating clocks.** Mayrhofer. 8d.

1889.

- 613, **Combined electric lamp-holder, fuze, and switch.** Naylor and Naylor. 8d.
- 2480, **Measuring electric currents.** Lake (Cutler). 1s. 1d.
- 5737, **Holders for electric glow lamps.** Bernstein. 8d.
- 8360, **Telephone systems.** Holcomb. 8d.
- 8619, **Electrical alarm for steam-boilers, &c.** Siegmunn. 6d.
- 9589, **Electrically indicating direction, &c., of engine shafts.** Ricketson. 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.	Name.	Paid.	Price Wednes day
12 Feb. 1/2	Anglo-American Brush E.L.	—	—
12 Feb. 2/0	— fully paid	—	—
14 Nov. 0/4½	Con Telephone & Main	1	2½
27 July 10/0	India Rubber, G. P. & Tel.	10	19½xd.
.....	House-to-House	4½	4½
.....	Metroptn Electric Supply	—	2½
.....	London Electric Supply	5	3½
.....	Swan United	3½	4½
12 July 12/0	Telegraph Construction	12	43½
2 July 6/0	— 6%, 1889	100	105
29 Nov. ... 5/0	United Telephone	5	15½

NOTES.

Berkshire.—The electric light has been successfully introduced at The Swan Hotel, Shillingford, near Wallingford.

More Gas-Electrics.—The Gas Company at Metz has decided to construct a central station for the public supply of electricity.

Holborn.—It has been recommended at the Holborn District Board that a license should be granted to the Gwynne-Pilsen Company.

Electric Railway at Budapest.—An electric railway, constructed by Messrs. Siemens and Halske, was opened at Budapest on July 30.

Vienna.—The west end of Vienna is shortly to have an electric lighting station, the concession for this having been granted to M. Capilleri, a Viennese engineer.

Barnet.—New boilers, engines, and dynamos have now been fixed at Barnet. The appointment of a lighting inspector is under consideration by the Lighting Committee.

Personal.—Mr. C. E. Brown, of Oerlikon, is now in England. He has visited Ferranti's Deptford installation, and also the Westinghouse installation in Sardinia-street, now well towards completion.

Meeting in Paris.—A joint meeting of the Institution and the Société Internationale des Electriciens is fixed to be held at Paris to-day, Friday, the 23rd August, to be followed on subsequent days by excursions to places of scientific interest.

New Use for Storage Cells.—The Pumpelly Storage Battery Company, of Chicago, have leased a factory in Indiana, and are turning out 200 cells a day for use with the phonograph, under a contract with the North American Phonograph Company.

Burton-on-Trent.—At Burton-on-Trent the proprietor of a cotton-mill has offered to let the water power on lease for the purpose of generating electricity for the electric lighting of Burton. The gas manager has been asked to report upon the matter.

Eiffel Tower Struck by Lightning.—The Eiffel Tower was struck by lightning during the storm on Monday night. The electricians felt a tremendous shock, and some molten metal was seen to fall from the conductors, but otherwise no damage was done.

Electric Lighting in Formosa.—The acting British Consul at Tamsui, in a recent report on the trade of Tamsui and Kelung, mentions that "the new city of Tai-pei Fu, the capital of the island, is lighted by electricity, the apparatus being solely in charge of native officials."

Brooklyn.—Before many months Brooklyn will have a plant of 50,000 Edison lamps running. Much of the work is now completed, and a trial is anticipated some time this month. The wires are underground, in iron tubing, and some 2,000ft. are now being laid every day.

The Heisler System.—The United Gas Improvement Company, of Philadelphia, is reported to have secured the controlling interest in the Heisler Electric Light Company, of St. Louis, employing the long-distance system of series incandescent lighting, now on view at the Paris Exhibition.

Stockholm.—The Gas Company of Stockholm having been greatly disturbed by the continued progress of the electric light—103 arcs and 3,832 incandescents having

been installed in that town during the past year—has decided to erect a central station for the supply of electric light itself.

The Jensen Bell Co.—The business of the Jensen Electric Bell and Signal Co., of London, is advertised to be sold by auction early in September by Messrs. Wheatley Kirk, Price and Goulty, as a going concern, together with the various patent rights, stock-in-trade, fittings, etc., used in connection with the business.

Chapel Lighted Electrically.—A new Baptist chapel in Okehampton was opened last week. It is seated for 400 persons, and is lighted by electricity, being the first village chapel in the south-western counties in which the electric light has been adopted. Mr. Henry Green, of Okehampton, was the builder, and the outlay has been £1,300.

1892 Exhibition.—We note that Chicago is attempting to secure the World's Exhibition of 1892 for itself, but we think it would be a mistake to have it out of New York, on account of the difficulty Old World visitors would have in travelling so much further overland. New York will probably not let the proposition be taken out of its hands.

Bournemouth.—A notice from the Anglo-American Brush Electric Light Corporation of their intention to apply to the Board of Trade for a provisional order authorising them to supply electricity for public or private purposes within the district of Bournemouth, and asking for the consent of the Council to the application, was referred to committee.

Parliamentary.—In the House of Lords, on August 15th, the Electric Lighting Provisional Orders Bills 2, 3, 4, and 5 were severally read a third time and passed. The Earl of Crawford and Balcarres expressed the opinion that the meter and testing clauses in these Bills would prove unworkable, and that recourse to Parliament would again be necessary.

Electrical Execution.—The physical laboratory of Harvard University was recently struck by lightning. We wish, says the *New York Sun*, à propos of this and of the recent discussions, that the men of science who are competent to speak on the subject would tell us less about making electricity kill people and more about preventing it from killing them.

Folkestone.—The Folkestone Corporation have decided to light the greater part of the town by electricity, the official seal having been fixed to the contract of Messrs. Crompton and Co. No less than five companies have intimated their intention to the Town Council to apply to Parliament for powers to supply the electric light to private consumers in the town.

English Measuring Instruments.—There is a great demand for Ayrton and Perry ammeters and voltmeters reported in America, one firm in Philadelphia having been unable to keep up with the demand. Cardew voltmeters are also in great request. Generally our instruments of precision are highly thought of over in the States, and there is a very large field for export.

Birmingham Electrical Exhibition.—The exhibition at Bingley Hall is increasing in popularity. The attendances last week were considerably in advance of those of the preceding week, and on Saturday the number of admissions was the highest yet recorded. The coal mine is now in good working order, and there are few visitors who do not desire to see the miners at work.

Rochester.—Notices were read at the last Town Council meeting from the secretary of the South of England House-to-House Electric Light Company, of the Municipal Electric Light and Power Company, Limited, and of the Electric Construction and Maintenance Company, Limited, of their intention to apply to the Board of Trade for a provisional order as to the supply of electricity in the city.

New Electrical Manufactory.—Extensive new works for the manufacture of electric machinery of all kinds are being erected at Heaton, Newcastle-on-Tyne, by Messrs. C. A. Parsons and Co. When this new manufactory is completed, Messrs. Parsons, who are still carrying on their business at Park-road, Gateshead-on-Tyne, will remove there. It is expected that this will take place in about six or eight weeks.

Electric Light at Sewerage Works.—The extensive work at the Barnhurst for the Wolverhampton Sewerage Committee having to be finished at short notice, the electric light has been used. The tender of Messrs. Elwell-Parker, Limited, for supplying dynamo, arc lamps, etc., for the works at the sum of £106. 10s., and to furnish competent men to fix the same, at the sum of 30s. per week for each man, was accepted by the Town Council.

Telemeter.—The extensive uses of the telemeter—which was described at the last British Association meeting—for transmission of the indications of thermometers, barometers, clocks, or pressure gauges, the height of water, oil, or gas holders at a distance, or other purposes of this kind is fully illustrated in the issue of the *Scientific American* for August 3rd. The instruments are manufactured by the Standard Thermometer Company, of Peabody, Massachusetts.

Electric Welding.—It is rumoured, says the *Electrical World*, that the Thomson European Welding Company will not manufacture its machines in America, but will establish factories in five European countries. This movement is made imperative in order to hold patents in those countries. At Lynn several machines are in process of manufacture for foreign shipment. Work will be immediately commenced in the erection of factories in foreign countries, and it is hoped they will be in operation within three months.

Eastbourne.—Memoralists at Eastbourne have complained of the smoke and "horrible smell" issuing from the works of the Eastbourne Electric Lighting Company, and attributed their sore throats and other affections to it. The Mayor, before whom the motion was raised, is in the unfortunate position of being also the chairman of the electric light company, and had to advise that they should serve him—that is to say, the company—with a notice, and if it was not stopped indict him or them for a nuisance.

Board of Trade Report.—In the House of Lords, Lord Crawford, in connection with the Board of Trade enquiry, remarked that there was a great desire on the part of numbers of persons interested in the industry to procure copies of the evidence and proceedings. He had communicated with the Board of Trade, who objected solely on the ground of expense. Earl Limerick, in reply, regretted that on this ground they were not justified, unless some strong case were made out, in printing the 1,300 pages of the report.

Medals for Electrical Inventions.—The Committee on Science and Arts of the Franklin Institute, Philadelphia, U.S., have recommended that awards of the John Scott medal and premium be given to W. Leigh

Burton, M.D., of Richmond, Virginia, for his "Electric Heater" (described by us, vol. ii., p. 195); to Alex. Crawford Chenoweth, of New York, for his "Method of Laying Continuous Electrical Conduits"; and to Charles McIntyre, of Newark, New Jersey, for his "Improvement in Electric Wire Connectors."

City Lighting.—Nothing seems yet to be settled with regard to the City lighting, and we are still waiting to learn what will be done. The *City Press* points out a danger in delay, saying: "Such discussions as took place at the last meeting may lead to a reconsideration of the whole position. If the Commissioners of Sewers, who assert certain powers, do not exercise those powers, it must not be forgotten that at our door is another body which claims to be the local authority for the whole metropolis, and is perfectly ready to enforce that assumption by enthusiastic efforts."

The Burton Electric Heater.—Experiments with the Burton electric heater on railway cars at Richmond, Virginia, seem to show that there is great possibility of its coming into practical usefulness. The experiments, according to calculation, are said to show that the cost of warming a car thoroughly in about half an hour is about 3d., and the cost of maintaining a temperature of 25deg. above the exterior temperature would be almost $\frac{3}{4}$ d. an hour. A number of railroad engineers have inspected the heaters on the car, and express themselves interested in its working.

Chester.—A special meeting of the Council of Chester will be held in the Council-chamber, Town Hall, Chester, on Wednesday, the 18th day of September, 1889, to consider as to making application to the Board of Trade for a provisional order under the Electric Lighting Acts, 1882 and 1888, authorising the supply of electricity for public and private purposes by the Corporation within the urban sanitary district of the city and county borough of Chester, and if so determined to resolve that application be made accordingly, and to make any further or other orders in reference thereto which the Council may deem necessary or advisable.

Fines for Exhibitors.—The *Birmingham Daily Post*, in commenting upon the unreadiness of exhibitors generally, but *apropos* of the Birmingham Exhibition on opening day in particular, asked Why has the system of inflicting a small fine upon exhibitors for each day's delay after opening never been yet tried? This should stimulate their efforts, which are now left to their honour, but in no way affect their purse. We commend the suggestion to Edinburgh. There is one thing, however, to be thought of, that only those who exhibit know the immense cost they are put to, and possibly if any increase is made they might decline to exhibit altogether.

Paris Lighting.—The lighting of the Place du Carrousel in Paris until last week has been run from a temporary installation put up by the Société Lyonnaise. The Edison Continental, who have the concession, have now made connection underground with their station at the Palais Royal. The cables crossing the Place du Palais Royal and the Rue de Rivoli are placed within the sewers. They are insulated and lead-covered part of the way, but for the remainder are bare copper carried on porcelain insulators. The lighting is obtained from six Pieper arc lamps taking 10 amperes, fixed on ornamental lamp-posts at a height of 20ft. from the ground.

Wave Motors.—Various kinds of wave motors have been proposed and some tried, and of these we have mentioned several as possibly applicable for storage of power

for lighthouses or other purposes, or as interesting in the development of the application of natural forces in this direction. A new system of this kind, invented by Mr. N. O. Bond, is reported as now in operation at Ocean Grove, New Jersey. In this a series of swinging gates is used to utilise the force of the waves, each wave as it rushes in pressing the gates inward at a pressure of 500 to 800 lb. per square inch, and the motion thus obtained is used, by means of levers, to actuate pumps.

Plymouth.—The Devon and Cornwall Electricity Supply Company have received much support in Plymouth. Upwards of 3,000 incandescent lights have been definitely ordered for various shops, private establishments, and public places, which more than warrants the company in going forward with their operations. Plant is to be laid down in the first instance for 4,000 incandescent lights and 100 arcs, and when lamps for this amount have been ordered no further engagements will be entered into until additional plant is introduced. It is hoped that before winter sets in the electric light will become pretty general in the principal establishments of Plymouth.

Launceston.—The Launceston Gas Company are wise in their time. At the meeting of the Town Council last Monday, a communication was received from the Devon and Cornwall Electricity Supply Company asking for the consent of the Corporation to an application to the Board of Trade for a provisional order authorising the supply of electricity for public and private purposes within the urban sanitary area. To the surprise of the Council, most of whom expected opposition, acquiescence in the request was proposed by the chairman of the gas company, and seconded by the manager of that undertaking. Supported from such an unexpected quarter, sanction was readily granted.

Bradford Nearly Ready.—At the Bradford Town Council, last week, Alderman F. Priestman, in moving the adoption of the proceedings of the Gas and Electricity Supply Committee, said: The arrangements for the installation of the electric light were now practically complete, and within the next week probably the members of the committee would have an opportunity of witnessing a test of the installation at various points. He should propose that the installation be handed over to Messrs. Siemens for six weeks, in accordance with the terms of their contract, after which the Corporation would take the matter into their own hands. After September 1st the contracts for the supply of the electric light would come into force.

Morecambe.—Correspondence having been received from the solicitor to Messrs. Andrews and Preece, electricians, Bradford, requesting the Board's consent to a provisional order authorising that firm to supply electricity within the district, and stating that they had received instructions to apply for power for the working of the trams between Morecambe and Heysham by electricity, the Morecambe Board have resolved that they could not give their consent until a draft of the provisional order had been submitted for their perusal. It was stated that the firm in question were now preparing to light up a few lamps on the front with the electric light as an experiment for the Board's inspection with a view to lighting the town by electricity.

Paris Congress.—The International Congress of Electricians at the Paris Exhibition will be opened tomorrow, Saturday, the 24th August, at 10 a.m., in the Conference Hall at the Trocadero. A prospectus relating

to the preliminary reports on the principal questions to be submitted to the congress has been distributed to the members. It contains the following reports: M. Pellat, on electric standards; M. A. Pottier, on measuring instruments; M. de la Touanne, on telephones; M. Pigou, on transformers; M. Hillairet, on dynamos; M. Hippolyte Fontaine, on electric lighting; and M. D'Arsonval, on electro-physiology. It will be remembered that applications (with subscription, 20 francs) for membership should be addressed to M. Mascart, 44, Rue de Rennes, Paris.

Electric Lighting Inspector for Liverpool.—A special meeting of the Watch Committee of the City Council was held on Wednesday at the Municipal Offices, Liverpool, for the purpose of considering the applications for the position of electric light inspector for the city. The duties of the office consist of the inspection of the apparatus and arrangements for the supply of the electric light, and the testing of the light itself. The salary is £160 per annum, from which 5 per cent. will be deducted for the superannuation fund. There are 45 candidates, and the committee carefully considered the qualifications and testimonials of each. Eventually the number was reduced to seven. These will be submitted to the Watch Committee at its ordinary meeting next Tuesday, and the appointment will then be made.

Marienbad.—The central electric lighting station just opened at Marienbad, constructed by Ganz and Co., of Budapest, was originally intended for 35 arcs for the streets, and 1,200 incandescents for private houses, but the demand for light has so far exceeded the first intention of the engineers, that they have had to install 1,800 incandescents, and have at the same time put in dynamos for 48 arcs. The station is about $1\frac{1}{2}$ miles from the town, and contains four sets of machines, one being for reserve. Each set consists of a Zipernowski alternating dynamo of 50,000 watts, driven direct by a Westinghouse engine of 80 h.p., at 500 revolutions. An exciter of 3,000 watts is driven from the same engine by means of shafting. The line wires are carried on posts placed at distances of 30 yards. After midnight the arc lamps are switched out and replaced by incandescents.

Southampton.—With reference to the application of the Town Council of Southampton for sanction to borrow £1,440, for the purposes of electric lighting, the Local Government Board has written to the town clerk that they had submitted a case to the law officers of the Crown on the question whether local authorities were empowered to manufacture electricity for lighting the streets, markets, and public buildings in their district, without obtaining a license or provisional order under the Electric Lighting Acts. Their opinion was that a provisional order must be obtained. At the Council meeting at which the letter was read, Mr. Cleveland asked what would be the cost to obtain a provisional order. The Town Clerk replied there would be certain fees to be paid, but he could not then exactly say what the cost would be. The communication was then referred to the Special and General Works Committee.

Tenders for Spain.—Electric lighting enterprises seem to be on the move in Spain. The *Gaceta de Madrid* publishes the conditions of the proposed electric scheme at Palencia, but as the tenders have to be sent in by the 31st inst. there will be little time for English manufacturers to compete. The caution money is put at 1,000 pesetas (the peseta is about 9d.); the contract is for 30 years. There

will be required 300 20-c.p. lamps for the public lighting, and there will be a subsidy of four-hundreds of a peseta (0.36d.) per lamp hour for each 20-c.p. lamp. Lighting to be carried on for at least 1,800 hours per annum. The *Boletín Oficial* of Orense publishes an announcement with reference to an electric lighting scheme in that town, to be decided on the 30th inst. The caution money in this case is 5,000 pesetas. The number of lamps is put at 250, of 10, 15, and 35 c.p. The price to be paid for public lighting is four centimes or hundredths per lamp hour of 10 candles, six centimos for 15 candles, and 10 centimos for 35 candles. The duration of the lighting is to be 2,200 hours per annum.

Central Station for Calcutta.—According to the Indian daily press, Messrs. Octavius Steel and Co., a well-known local firm of merchants, acting as agents for Messrs. Crompton and Co., of London, have on hand a scheme for lighting by electricity that portion of Calcutta over which the Port Commissioners have control, including the Hooghly Floating Bridge and the jetty enclosures. This area is to be illuminated on condition that the Electric Light Supply Company will establish a central station, for which purpose the Port Commissioners have offered the company a plot of ground adjoining the Riverside Press. The lighting will be done by means of 51 arc lamps, of which number six will be allotted to the Hooghly Bridge. Messrs. Gillanders, Arbuthnot, and Co. and the Bank of Bengal also propose to avail themselves of the opportunity thus afforded of illuminating their premises by electricity. The electricity will be supplied by meters, a system which will be extremely useful for private houses. The alternating-current transformer system is to be adopted on account of the great distances between houses in Calcutta. The engines employed by Messrs. Crompton will be Willans engines coupled direct. The dynamos, arc lamps, and all electrical plant will be manufactured by Messrs. Crompton and Co. at Chelmsford. An important point for consumers will be the use of meters, which will be placed in a closed box with a glass pane let into the door, through which the consumer can at any time inspect his consumption of electricity. The secondary or lighting circuit will be connected with the earth, so that in the improbable event of a connection occurring between the two circuits, the high-tension current passes to the earth, and is rendered harmless. Mr. Davies, Messrs. Crompton and Co.'s representative, is returning to England by the next mail steamer to assist in designing the plant for the generating station, and hopes to have the amount of lighting at present arranged for in full work within a year from now.

Success in Electric Tramways.—The electric railroad business is fairly booming in Boston, U.S., where the overhead system has been introduced. The stock of the company has been increased four and a half million dollars in order to perfect and extend the system. Some remarkable statistics of the results in this city are given by Mr. Whitney, the president of the company. In the first place, he showed that the electric cars already running have for months been making one-eighth faster time than the trains on the New York elevated roads, yet the people do not have any long flights of stairs to climb. Then Mr. Whitney reports that the Arlington electric line, in 17 days, has shown an increase in travel of 150 per cent. That this is not a mere spurt is shown by the fact that, on the Cambridge electric branch running since Feb. 16, the regular steady travel has increased absolutely more than double 150 per cent. since its opening. On the Brighton line, also, the

receipts for June, this year, are double what they were in June, 1888. The increase with the horse service has been 10 per cent. annually. As to depreciation, Mr. Whitney mentions that the other line using horse-cars has to charge no less than 150,000dols. a year for depreciation in horses. He further states that the cost of motive power with horses has been 10.16 cents per mile, whereas on the Allston electric line, under many disadvantages, the cost of electric power is only 1½ cents for fuel and 2½ cents for care of motors, lines, and apparatus, making a saving on power of at least five cents per mile, and besides this there is a further saving, by no means small, in the acceleration of speed. Mr. Whitney adds: "I am happy to say that since these roads have been put into operation they have not only met the highest expectations of the company, but they have more than fulfilled the hopes of the community. For full testimony on that fact I refer to every single unprejudiced citizen of Cambridge, Brookline, and Boston who has had occasion to use the cars, and witness the operation of the road."

Urging the Gas Companies.—Those in authority in gas undertakings still disparage the usefulness of electric light, and deprecate any feeling of fear at its spread. Our spirited gas and electric contemporary is incessant in urging the gas companies to take up the supply of the superior, as well as the inferior light. "*The public will have the electric light,*" it truly observes, in a leader this week. "It is absurd to argue the point. Are not gas suppliers all over the country moving heaven and earth to increase the consumption of gas for cooking, heating, and motive purposes in order to be able to show increase in consumption? Have we not the authority of the governor of the Gas Light and Coke Company, Col. Makins, M.P., for the statement that the number of users of the electric light in the district which the company supply has increased in six months nearly 15 per cent., and that there are now to their knowledge 581 users, and this, be it remembered, without any parliamentary powers, and with every possible difficulty placed in the way of the suppliers? We do earnestly hope that in order that the electric light may progress and become commercially successful, the policy advised may be supported financially and practically by all interested in the supply of light, especially those interested in gas undertakings who have money to invest and business ability to organise and control commercial undertakings, which without doubt those supplying electricity as a lighting agent will shortly become." We are for the spread of electric light in every possible way, and for the introduction of it in addition to gas works as well as separately by electric companies. In one or the other it will spread, and it is for the companies to say whether in their direction or not. One of the largest of the American gas corporations in the Northern United States has now definitely given in its adhesion to the electric supply, and have arranged for co-operation with a well-known electric company. In France several gas companies have arranged for supply of electric light, and it must be so in England, or the companies must inevitably eventually suffer.

Electric Treatment of Sewage.—Very satisfactory trials of the disinfection of sewage by electricity have taken place, says the *Bulletin Internationale de l'Electricité*, at Rouen. The process employed is that of M. Hermite, and is simply a variation of his electrolytic process of bleaching. In the case of bleaching, M. Hermite submits a solution of chloride of magnesium to action of the electric current, the products of the decomposition having an ener

getic oxydising power. The electrolyte might be used for the disinfection of sewage water, but by reason of the high price of this chemical, chloride of sodium (sea salt) is used at Rouen. Since the process necessitates the use of a chloride, the most favourable case is that where there is at disposal water containing the chloride in solution, such, for example, when the town is a port on the sea coast. In this case, for cleaning the pavements and flushing the gutters, fresh water would be replaced by sea water which had been previously passed through the electrolyzers, and in allowing this disinfectant to flow along the gutters the air itself would be made healthful, at the same time preventing infection of the harbours by the sewage. For this it is simply necessary to erect a station, with engines, dynamos, and electrolyzers. When the towns are not situated on the sea coast the process hardly presents the same advantage, because of the necessity for the addition of the chloride; but where factories are established producing chlorides as residue products, as is the case at Rouen, the addition this necessity would present no great difficulty. Besides the treatment of sewage, M. Hermite proposes the application of his process to the disinfection of the wards of hospitals, garrisons, etc., and instead of employing chloride of calcium, which has a penetrating odour, it will be sufficient to use in the electrolyzers ordinary water, in which 2.5 kilogrammes of sea-salt is added to the cubic metre, and to employ this liquid for washing the floors and walls. In the experiments made at Rouen the engine operates at the same time both the pump for raising the liquid to be disinfected, runs the dynamo, and agitates electrolyzers. The dynamo used is a Phoenix machine, giving 1,200 amperes at six to seven volts, supplied by Paterson and Cooper, who have manufactured and supplied the plant for M. Hermite's bleaching process. The electrolyzers are similar to those employed in bleaching. The trials undertaken show the process in a very favourable light, but it will be necessary to await tests extending over a longer period before the results can be considered practical, or data of the cost of running can be obtained. Similar trials have just taken place at Paris, upon the sewage accumulated at La Villette. Although the results have not yet been published, it is understood that they are not unfavourable to the electro-chemical process of disinfection.

Two Hundred Miles an Hour.—The following dramatic particulars are published in the *Financial News* of the experiments now in progress at Laurel, near Baltimore, U.S., with a new form of electrical transit. A speed of two miles a minute, it is said, has been already obtained, and the inventor, Mr. Weems, claims the power of working regularly at a speed of 200 miles an hour. It is not proposed "as yet" to carry passengers by this summary method, but it is hoped to organise a service of mails and light parcels between some of the chief cities of the Union before long. The system is thus described: "The railway has two rails, very much like any other railway, but it is enclosed—here in a sort of lattice work, and there by a barbed-wire fence which stretches along on both sides. But the queerest thing about this railroad is what travels on it. Mr. Weems, standing in the door of a shed, touches a button, when out of the shed crawls an iron-plated thing, about 2½ ft. square and 20 ft. long, pointed at one end. It is on wheels, and looks very heavy and clumsy. No sooner have you begun to look it over and wonder whether it

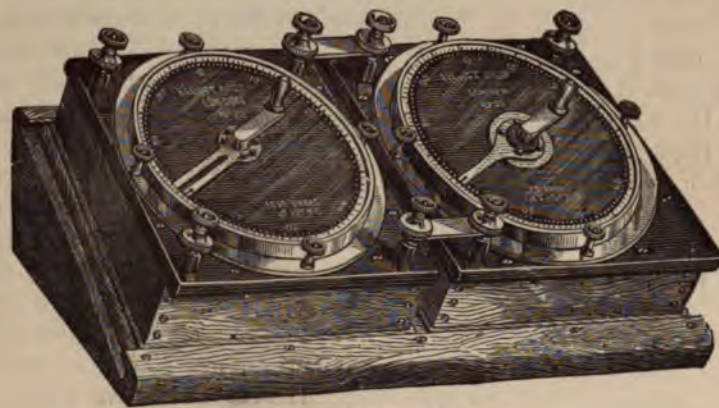
is a torpedo or a rock-crusher than it disappears. It goes off like a flash. Apparently, nothing touches it, nothing propels it, but it goes. A little rumble, a dark streak going round the curve of the circular railway, and it is hidden behind a clump of trees. Mr. Weems still stands with his hand on the button, watching a pencil moving in an automatic device over a piece of ruled paper. 'At the half!' he exclaims, and a moment or two later 'One mile!' Then 'A mile and a half!' and in a few seconds more the long, black thing on wheels whizzes by. You take out your watch and time it. In a little less than a minute it reappears. In another minute it whizzes past once more. As it goes round and round it is like nothing so much as a big shuttle moving in a circle with inconceivable rapidity. The track is exactly two miles in circumference. 'We are not running very fast now,' Mr. Weems says; 'only 1,400 revolutions of our motor. This gives us a speed of exactly two miles a minute. Our machines develop up to 10,000 revolutions, and we have run them 3,500 revolutions—equal to more than four miles a minute—for 24 hours without stopping. On a first-class track, reasonably straight, and without too many steep grades, we can easily develop a continuous speed of three to four miles a minute. In fact, there is practically no limit to the speed that our power can produce. The only question is, how much speed the tracks and cars are able to stand. The track we are now using is all curve and full of heavy grades.' Within a very few years there will be a double track electric railway from New York to Chicago, about 900 miles long. The track will have a 12 in. gauge, and will be enclosed in a network of barbed wire. The wires of which this fence is made will be used for telegraph, telephone, and automatic signals. Overhead will be space for carrying 100 commercial telegraph wires. The track is so light and the rolling stock so easily carried, that at very small additional cost the road can be elevated through towns and cities, and wherever it may be necessary to obviate heavy grades. Though this protected way trains, 2½ ft. wide and of about the same height, will be run at the speed of 200 miles an hour. No enginemen, conductors, or brakemen accompany the train, whose movements are controlled easily and absolutely from the power stations. Of these stations there will be one in New York, one in Chicago, and seven on the line about 100 miles apart. These power stations will require a capacity of about 300 h.p. each, and any practical engineer can compute the cost of maintaining them. It is really trifling, considering the efficiency developed. If water power can be had for some of the stations, even if five or ten miles from the track, it will be utilised, power being transmitted by wire. In operation, trains of four or five cars will be run, a motor car and three or four others. The cars are so telescoped together as to form unbroken surfaces, top, bottom, and sides, and the rear car, as well as the first or motor car, is pointed so as to offer the least possible resistance to air. The movement of each train is automatically and accurately registered on a chart in the power stations. The slightest accident to the train, or the presence of an obstacle on the track, shuts off the connection. At the will of the dispatcher a train can be stopped at any point, backed up or started ahead again. The trains are therefore under complete control, and if traffic should not justify the building of a double track a single track could be efficiently operated."

PARIS EXHIBITION.—IV.

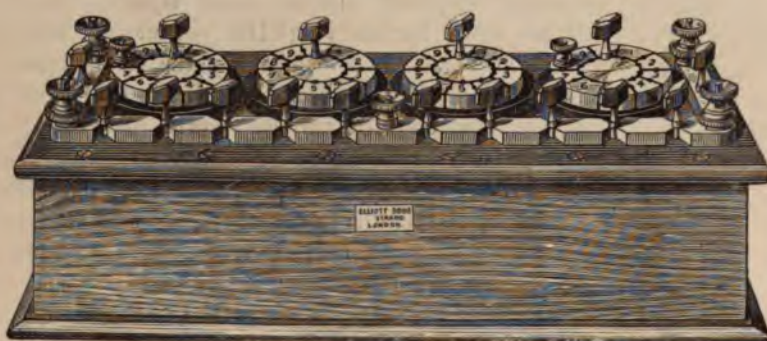
MESSRS. ELLIOTT BROS.' INSTRUMENTS AND SHIP SIGNALS.

Quite the finest show in the way of finish and beauty of detail in the English exhibit is the stand of the celebrated firm of electrical instrument makers, Messrs. Elliott Bros., 101, St. Martin's-lane, London. It is a fine kiosk completely filled with multitudinous specimens of the various kinds of telegraphic and electrical measuring instruments, perfectly finished and carefully mounted, for which the firm are noted throughout the world.

Ever since the invention of the telegraph and its introduction by Wheatstone and Cooke, Messrs. Elliott Bros. have been one of the principal makers of the delicate apparatus which have served to link country with country. Most of these instruments are now of a well-known and settled type, as used in the Post Office Department in England, for the cable telegraph companies, and by various foreign Governments. They consist of portable detector galvanometers, tangent



Sliding Resistance Coils.
Bobines de Résistance à Coulisses.



Large Set of Resistance Coils, Dial Pattern.
Bobines de Résistance à Cadran.

and reflecting galvanometers of various types, with shunts for same; Thomson's reflecting astatic galvanometer for cable work, and their lamp apparatus; resistance coils in many forms, as used for various testing purposes; with a copy of the legal ohm; also megohm, subdivided ohm, dial pattern resistance coils, the Post Office portable bridge and sliding coils, transmitting keys of numerous patterns, condensers, lightning dischargers, and set of Wheatstone apparatus. Of these we produce a few illustrations, showing the scope of Messrs. Elliott Bros.' productions, for our readers on the Continent. Several new types of apparatus are shown at this exhibit, among them being the new form of syphon recorder and vibrator recently introduced by the firm for cable work. One interesting feature is the complete repeater board, in the latest form as adopted by the Postal Telegraph Department of Great Britain, containing on one board, arranged for the greatest ease of inspection, testing, and manipulation, the following instruments: A Wheatstone's receiver, last Post Office form, driven by weight to 400 words per minute, two sounders, two condensers ($7\frac{1}{2}$ microfarad, with 2,000 ohms resistance), two single-current keys, three standard relays, two standard relays with springs, two differen-

EXPOSITION DE PARIS.—IV.

INSTRUMENTS TELEGRAPHIQUES, ET SIGNAUX POUR NAVIRES DE MM. ELLIOTT FRERES.

Comme fini et beauté de détail l'exposition de MM. Elliott frères, les célèbres fabricants d'instruments d'électricité, de 101, St. Martin's-lane, Londres, attirent l'attention générale. Leur magnifique kiosque offre aux regards de nombreux spécimens d'appareils électriques et télégraphiques, d'une fini et d'une correction parfaite, ce qui a valu à la maison sa renommée dans le monde entier.

Depuis l'invention du télégraphe et son application pratique, par Wheatstone et Cooke, MM. Elliott frères, ont été les principaux fabricants de ces délicats instruments qui ont tant contribué à établir des relations entre les différentes parties du monde. La plupart de ces instruments sont construits d'après un modèle d'un usage général tels que ceux employés dans les Bureaux de Poste anglais, dans les télégraphes sous-marins, et par plusieurs Gouvernements étrangers. Ils consistent en galvanomètres révélateurs portatifs, en galvanomètres tangents et réflecteurs de



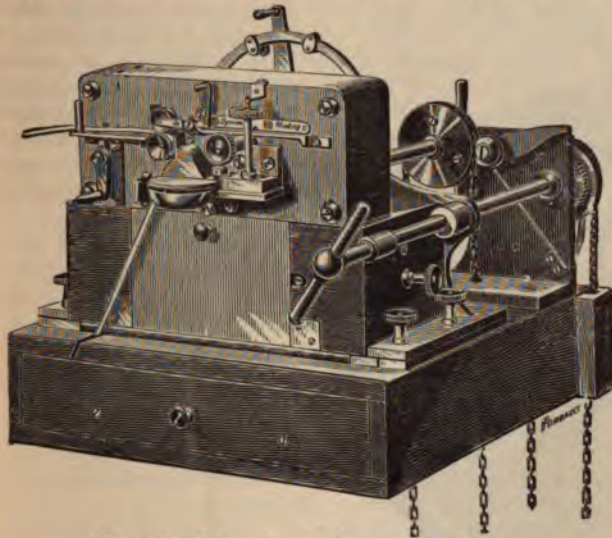
Thomson Astatic Reflecting Galvanometer.
Galvanomètre Astatique Réflecteur de Thomson.

différents modèles munis d'appareils de dérivation, en galvanomètres réflecteurs astatiques de Thomson pour câbles sous-marins, et appareils d'éclairage; en bobines de résistance de différentes formes, telles que celles employées pour essais; en exemplaire de l'ohm légal, du mégohm, de l'ohm subdivisé, en bobines de résistance à cadran, du pont portatif de Wheatstone avec bobines à coulisses, de clefs de transmission de nombreux modèles, de condensateurs, d'appareils de décharge électrique, et de modèles d'appareils de Wheatstone. Nous en donnons quelques dessins afin de montrer à nos lecteurs du continent une idée de l'étendue des productions de cette maison. On peut voir, dans cette exposition plusieurs nouveaux appareils, entr'autres, un nouveau modèle du "syphon recorder" et vibreur, récemment introduit par la maison pour les câbles sous-marins. Un appareil intéressant consiste en un tableau complet muni d'un appareil à répétition, d'après le dernier modèle adopté par le Bureau télégraphique général de la Grande Bretagne, comprenant, sur un seul tableau et distribué pour faciliter l'inspection, l'essai et la manipulation, les instruments suivants: un récepteur de Wheatstone, d'après le dernier modèle du Bureau de poste général, mu par un poids, à raison de 400 mots par minute,

tial galvanometers, two duplex commutators, two circular rheostats with vulcanite bobbins, two automatic switches, with all fixtures and connections, making a most compact and serviceable telegraphic set. Many of these have been supplied for small colonial telegraph stations. Speed indicators and pocket speed counters, and decimal wire gauges are also shown, as well as a number of electrical laboratory instruments of great delicacy, quadrant electrometers, and standard chloride of silver cells.

WILLIS'S ENGINE-ROOM TELEGRAPH FOR STEAMSHIPS.

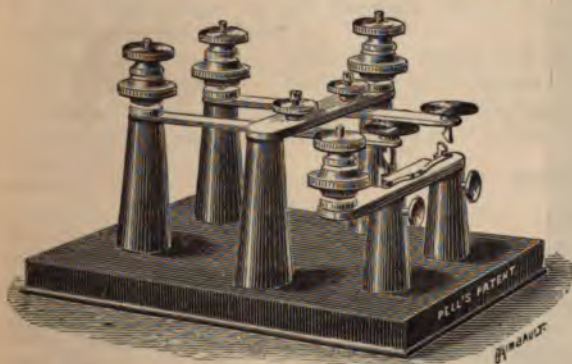
At the back of the stand is shown the complete system of electric signalling for steamships, invented by Mr. J. B. Willis, and manufactured by Messrs. Elliott Bros., for con-



Wheatstone's Receiver, 400 words per minute.
Récepteur de Wheatstone, 400 mots par minute.

veying the orders of the captain of a vessel to the engineer and to the helmsman, and repeating the same; together with Spratt's electric speed indicator for registering the revolutions of the engine.

The appearance of the Willis apparatus is shown in the illustration. In each case a large dial with a glass face, cased in metal, so as to be quite watertight, has directions marked in distinct characters, and is furnished with a movable index pointer. A handle, also furnished with a pointer, can be moved to any of these directions; and this movement is communicated by means of electrical contacts



Reversing Key, with Pell's Locking Arrangement.
Commutateur à enclenchement Pell.

inside to the index pointer of a second similar dial in the engine-room or the steering-house. The mechanism that secures this motion perfectly and without error is ingenious, and is designed to obviate any difficulty that might arise from the sudden movement of the handle under excitement of the circumstances, and to bring the receiving index always to the same order as that of the transmitter, whether moved backwards or forwards. This is obtained by having the contact inside, separate from the handle itself, but connected to it by means of a chain and a coiled spring. Then if the handle is moved, even suddenly, the spring is coiled, and the contact inside moves slowly step by step until it comes to the position at which the handle remains, when a spring-catch falls into position and locks the

deux sonneries, deux condensateurs ($7\frac{1}{2}$ microfarade, d'une résistance de 2,000 ohms), deux clefs pour courant simple, trois relais modèle, deux relais modèle à ressort, deux galvanomètres différentiels, deux commutateurs duplex, deux rhéostats circulaires avec bobines en vulcanite, deux commutateurs automatiques, avec toutes les attaches nécessaires, formant en tout un appareil télégraphique très compacte et très utile. Un grand nombre a été fourni à plusieurs petits bureaux de télégraphe dans les colonies. On voit également des indicateurs de vitesse et de petit compteurs de vitesse de poche, et des jauges décimales métalliques, en même temps qu'un grand nombre d'instruments électriques pour laboratoire d'une grande délicatesse, des électromètres à quadrants et des piles modèle à chlorure d'argent.

TELEGRAPHE WILLIS POUR BATEAUX A VAPEUR.

A l'arrière de la vitrine, on peut voir le système complet de signaux électriques pour bateaux à vapeur, inventé par M. J. B. Willis, et fabriqué par MM. Elliott frères. Ils sont destinés à transmettre, avec répétition, les ordres du capitaine d'un navire au mécanicien, et à l'homme du gouvernail, combiné avec un appareil électrique de Spratt indiquant la vitesse et enregistrant le nombre de révolutions de la machine.

Le dessin représente l'appareil de Willis. Un large cadran à face de verre, et garni d'une monture en métal, de façon à le rendre à l'épreuve de l'eau, marque les ordres en caractères distincts, et est muni d'un index mobile. Une



Wheatstone's Perforator.
Perforateur de Wheatstone.

poignée, aussi munie d'un indicateur peut être mue dans n'importe laquelle de ces directions, et le mouvement est communiqué, au moyen d'un contact électrique intérieur à l'indicateur d'un cadran analogue placé dans la chambre des machines ou celle du gouvernail. Le mécanisme qui règle ce mouvement avec perfection et sans erreur, est très ingénieux, et calculé de façon à prévenir toute difficulté résultant d'un mouvement soudain imprimé à la poignée sous l'influence des circonstances, et à ramener constamment l'index récepteur au même endroit que la poignée de transmission, que celui-ci soit déplacé, en avant ou en arrière. On obtient ce résultat en isolant le contact intérieur de la poignée, et ne communiquant avec elle qu'au moyen d'une chaîne et d'un ressort à spirale. Si l'on déplace la poignée, même brusquement, le ressort se déplie, et le contact intérieur est déplacé lentement par degrés, jusqu'à la position à laquelle la poignée est arrêtée, alors une détente tombe en place et arrête le contact. Ce contact mobile passe sur une série d'autres contacts, en nombre égal aux ordres marqués sur le cadran et déplaçant la poignée, envoie des courants successifs au récepteur de la chambre des machines. Le récepteur consiste en trois électro-aimants distribués en forme de triangle; chaque armature est munie d'une tige

contact. This movable contact passes over a series of other contacts equal in number to the orders marked on the dial, and moving the handle, therefore, sends successive currents to the receiving instrument in the engine-room. The receiving part of the mechanism consists of three electromagnets arranged in the form of a triangle, each of the armatures having a connecting rod, which converge, and are fixed to a small excentric on an axis carrying the pointer of the dial. The effect of the successive currents to these three magnets, one after the other, is to

de communication qui converge, et elles sont fixées à un petit excentrique sur un axe supportant l'indicateur du cadran. Le résultat de ces courants successifs sur les trois aimants, l'un après l'autre, est de faire tourner l'index au moyen du petit excentrique. De cette façon, le mouvement de l'instrument du capitaine est exactement communiqué à celui du mécanicien; mais si le capitaine déplace sa poignée trop brusquement, l'instrument du mécanicien reçoit le signal plus lentement et par degrés, et finit par s'arrêter à l'endroit convenable. Le courant pour les



Willis's Engine-room Telegraph.

Telegraphe Willis pour Bateau à Vapeur.

pull the index finger round by the motion of the small excentric. In this manner, the motion of the captain's instrument is communicated exactly to that of the engineman, but whereas the captain may pull his handle over suddenly, the engineer's instrument receives the signal more slowly step by step, eventually stopping at the right place. The current to work the magnets can be obtained either from a battery or from a dynamo. In the case of the engineer's instrument there are seven contacts only, but for the other instruments, to transmit more numerous indications, it is simply necessary

aimants peut provenir d'une pile ou d'un dynamo. Pour l'appareil du mécanicien il n'y a que sept contacts; mais dans le cas d'autres appareils exigeant des indications plus nombreuses, il suffit simplement d'augmenter les contacts, et au moyen d'un régulateur à ailes, comme on en emploie dans les horloges, de régler la vitesse du contact mobile.

Le système de signaux est comme suit: Le capitaine veut donner un ordre: pour déplacer la poignée il faut déplacer un petit levier qui se trouve derrière; un contact se trouve ainsi établi et fait retentir un timbre dans la chambre

to have more contacts, and by means of an air-fan such as used in large clocks, to regulate the speed of the moving contact.

The process of signalling is as follows: The captain wishes to give an order; to move the handle it is necessary to move a small lever behind the handle; this makes contact and rings a bell in the engine-room as a notice for the engineer to "stand by." The captain then moves his handle to, for instance, "half-speed ahead." The engineer receives this signal on his instrument, and thereupon puts his handle to the same position. This moves the index of the captain's instrument in the same manner, and he knows his signal has been received and understood.

In the steering telegraph the same process is carried out, the directions being degrees of the compass, and to the starboard or larboard; but in this case the repetition is given by the rudder itself, which therefore acts as a check upon the helmsman. Moreover, it is so arranged that if the helmsman departs more than a small amount from the fixed route, say, 5 deg., the apparatus indicates this by ringing a large gong, and registering the variation on the captain's instrument.

The Spratt electric speed indicator, though not part of the Willis system, is usually fixed together with it on board ship. It has been designed by Mr. Spratt, Messrs. Elliott Bros. foreman, to quickly and easily register the number of revolutions on a dial at any part of the ship. In this instrument three or more electromagnets working the numbers, are connected with contacts upon the main shaft. Clockwork, which can be started or stopped at the touch of a button, connects the mechanism for a quarter of a minute and then breaks the circuit. The main shaft makes contact four times in each revolution, and the number in the quarter-minute on the dial therefore indicates the revolutions per minute of the engine. A controlling electromagnet puts the whole back to zero for a fresh reading.

The Willis system of ship signalling is admirably adapted for the purpose required, and has been selected by the British Admiralty for use on board the ships of war. Its greatest advantages are the absence of pulleys and gearing necessary in mechanical signals; the possibility of placing the connections below water-mark, and, therefore, out of the danger of being shot away by the enemy; two or more instruments can be connected and placed in various parts of the ship, and the message can be sent or received from any of them, while if one is damaged the remainder still work; they are quicker in their action and easier to work, and the cost is less than that of mechanical system. But the chief advantage is the certainty and safety of its action, owing to the message being checked and replied to by the engineer.

The system has been applied on board Her Majesty's ships "Camperdown," "Rodney," and "Aurora," as well as on the Royal yachts "Albert," and "Victoria," and a double set has just been fitted to H.M.S. "Trafalgar."

des machines appelant l'attention du mécanicien. Alors le capitaine déplace sa poignée, par exemple, à "demi-vitesse en avant." Le mécanicien reçoit le signal sur son appareil et place sa poignée dans la même position. Ce mouvement déplace l'index de l'appareil du capitaine de la même manière, et il sait que son signal a été reçu et compris.

Dans l'appareil du gouvernail on se sert du même procédé; les directions sont les degrés de la boussole avec les mots tribord et babord; mais dans ce cas, la répétition est produite par le gouvernail même, et par conséquent contrôle le timonier. En outre l'appareil est disposé de telle façon que si le timonier se trouve hors de la route indiquée d'une quantité assez considérable, par exemple de 5 degrés, l'appareil l'indique en faisant résonner un timbre puissant, et en enregistrant la variation sur l'appareil du capitaine.

L'indicateur électrique de vitesse de Spratt, quoique n'appartient pas au système Willis, en fait habituellement partie à bord des navires. Il a été imaginé par M. Spratt, le contre-maitre de MM. Elliott, pour enregistrer facilement et rapidement le nombre de révolutions sur un cadran en n'importe quelle partie du navire. Dans cet instrument les trois électro-aimants ou davantage, qui agissent sur les chiffres, sont en communication avec des contacts placés sur l'arbre principal. Un mouvement d'horlogerie, qu'on peut faire marcher ou arrêter au moyen d'un bouton, met le mécanicien en rapport pour un quart de minute, et ensuite interrompt le courant. L'arbre principal établit le contact quatre fois par révolution, et le nombre pendant le quart de minute sur le cadran, indique par suite le nombre de révolutions de la machine par minute. Un électro-aimant contrôleur ramène le tout à zéro pour une nouvelle lecture.

Le système Willis de signalement pour navire remplit admirablement son but, et a été adopté par l'Amirauté britannique à bord des navires de guerre. Son grand avantage consiste en l'absence de poulies et autres appareils nécessaires aux signaux mécaniques; dans la facilité de placer les communications au dessous du niveau d'eau, et en évitant ainsi d'être enlevées par les boulets de l'ennemi; on peut installer deux ou plusieurs instruments dans différentes parties du navire, de façon à pouvoir transmettre ou recevoir un message par l'un d'eux au cas où l'autre serait endommagé. Ils sont d'une manipulation plus facile et plus rapide, et coûtent moins que les signaux mécaniques. Mais l'avantage principal est l'exactitude et la sûreté d'action dues à ce que l'ingénieur est obligé de contrôler et de répondre à l'ordre.

Le système est employé à bord les navires de Sa Majesté Britannique le "Camperdown," le "Rodney," et l'"Aurora"; et aussi à bord des yachts royaux l'"Albert," et le "Victoria"; et un double appareil vient d'être installé sur le "Trafalgar."

STANDARDISING.

We have received the following letter from the Secretary of the London Chamber of Commerce:

As there appears to be some misunderstanding on the subject of the recent circular sent out by this chamber respecting the proposed Government standardising laboratory, at the suggestion of Mr. Crompton, chairman of the section, I beg to call your attention to the following facts.

I have called on several of the leading instrument makers and asked them their opinion as to the value of the Kew certificate. I am informed that whereas the fee for examining thermometers, barometers, and sextants is very small—that is to say, averaging between the limits of 1s. and 2s. 6d.—the instruments carrying these certificates command from 20 to 25 per cent. higher prices. The watch certificates are given to a comparatively small extent, but similarly their value becomes enhanced to an extent far exceeding the amount of the fees.

It appears further to be admitted that the laboratories established by foreign countries at Berlin and Paris are used to a considerable extent for the certification of volt-

meters and ammeters, in addition to the principal work of testing house meters. These certificated instruments command a better price than those which are sold merely on the maker's reputation.

The British trade is placed at a disadvantage on the foreign market, as foreign-made instruments with such certificates are preferred to English instruments without them.

I also wish to call your attention to the fact that all instruments used under the Electric Lighting Acts will have to be certified, and it is obvious that the purchaser of such instruments will prefer to buy them of a maker of such certified instruments rather than take the trouble of getting them certified himself.

Should the above facts cause you to modify your views, I should be glad if you will send in another return of the probable number of instruments you are likely to send in for certification.

The returns of house meters, which have already been received from five sources only, amount to nearly 17,000 per annum.—Yours, etc.,

KENRICK B. MURRAY.

THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence ; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices :

139-140, SALISBURY COURT, FLEET STREET,
LONDON. E.C.

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IMPORTANT NOTICE.

We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No paper that we know ever refuses Subscribers or Advertisers. Nor do we; in fact, we invite them, believing that they will get full value for their money.

Specimen copies of the paper will be sent on request.

THE BRITISH ASSOCIATION.

At the beginning of next month, for the third time in its history, the British Association meets at Newcastle-on-Tyne. As each year rolls round and the annual gathering takes place, those who chronicle its history are fain to note the progress made since the previous meeting. Little enough it seems from year to year, but when the period reaches from the previous meeting at any particular town to the present one there is no difficulty in marking time. A writer in 1863, commenting upon the meeting, remarked, "Three centuries back, it was the fitful twilight that ever and anon shot athwart the blackened dome from some monkist cell, indicating the first streak of dawn as not far distant." With a very slight modification the sentence could be made applicable to electrical science in 1838, the date of the first meeting, 1863, the date of the second meeting, and 1889. The writer we have quoted goes on to say, "Gradually the first glimmer of steady light was visible, it rose, it increased until the shades rolled back, and the orient had become resplendent with red and gold which ushered in the morn, the natal day of modern science, and the car has continued to roll on, and on, and on, until we are near to its meridian, and on it must ever roll, and its sun know no westering wave." If anyone will take the trouble to enquire he will find that the period of 1836 to 1839 may well be said to be that when the first "glimmer of steady light was visible," so far as some of the most important industrial applications of electricity are concerned. In 1836 De la Rue noticed the possibility of getting fac-simile plates of copper by depositing copper. In 1839 Jacobi, Spencer, and Jordan inaugurated the industry of electro-deposition. But a greater departure had been taken in 1837 in the construction of electric telegraph lines. This departure ushered in the morn of a revolution in the world's history. Soon after the introduction of land telegraphy the idea of submarine telegraphy was mooted. Various experiments were made in the forties, which paved the way for the rapid progress in the fifties. In the latter part of the thirties, and also in the forties, both arc and incandescent electric lighting were tried with more or less success when considered as scientific experiments, but as failures when considered as commercial speculations. It was not till towards the close of the fifties that electric lighting was adapted to lighthouses, and not till long after was it adapted to general illumination. Fifty-one years have passed since the first meeting of the British Association at Newcastle, and practically the whole of the numerous applications of electricity, now so essential to the well-being and the happiness of the nations, have been developed in that period. Up to the second meeting in 1863, the important develop-

ments had been connected with telegraphy and deposition. It has been during the second period, from 1863 to 1889, that the greatest strides have been made. First, the Atlantic was conquered, and submarine telegraphy became as common as overland; later on Gramme gave us the modern dynamo which has opened up so vast a field, that we are only now just on the borders; Bell, Edison, and Hughes gave us the telephone and the microphone, which threaten to become far more serviceable and universal than the telegraphs. Some hints are being disseminated that we are even now in the birth throes of compassing electric photography at a distance. Of course we do not know to what the hints allude, but if they merely refer to the production of a fac-simile of a photograph or a picture, there is not much difficulty in doing it, but if they refer to something different from this, we await the development with great interest. For the transmission of a photograph or picture, some modification of Bakewell's apparatus would be found to answer, and we do not know but a photographic negative or positive could, with a very little manipulation, be so transmitted. What exactly is the action of the light upon a dry plate? Is the portion unacted upon a conductor, and does the portion acted upon vary its resistance in proportion to the action of the light? Are we indeed to witness an entirely new departure in the near future, and get far-seeing as well as far-speaking and far-writing. Prof. Lodge thinks that the next twenty years will see us with a greatly extended knowledge of the connection between the ether and electricity, and who can tell but that the period between the present meeting at Newcastle and the next meeting, about a quarter of a century hence, may be as fruitful in surprises as the last period in matters electrical.

Sir W. Armstrong, the president in 1863, referred to electricity as being supposed likely to furnish a substitute for coal, and showed that it could not do so as generated by batteries. We can go much further than this now, and say that by no known process can electricity be generated with sufficient economy to act as a substitute for coal. With the apparatus at our command now, coal is the primary actor. Its combustion raises the steam by means of which the engines are driven, which again drive the dynamos generating the electric current. The loss of energy between the coal and the electric current is enormous. The only suggested way of getting electricity cheaper, so far as we know, is to get it direct from the coal, and, presuming this possible, so long as we are dependent upon coal for our electricity there can be no possible chance of the latter furnishing a substitute for the former. Thus we find that it is not always possible to progress upon suggested lines—time showing the ideas to be based

upon imperfect information. It may be said the natural way to generate cheap electricity is to utilise Nature's productions—wind and water; but though the idea is tempting enough, nobody seems to have found a way to carry it out in practice. This brief review will show that though a mass of work has been done during the two periods mentioned, the next period opens with plenty of room for further work. If—and there is much in an if—the next period only solves the problem of obtaining our current direct from coal it will be a great step, leaving to a more distant time the problem of obtaining the electricity from sources other than coal, with a view to use it in substitution to the black diamond. We have never favoured the alarmist views of the late Stanley Jevons, and it is immaterial for present purposes to attempt to discuss what will happen a hundred years hence. The degeneracy of England will not be because of the failure of its coal supply, but from other causes into which it is not for us to enter. Perhaps the fundamental question for those whose aim is to get cheap electricity lies in chemical action. Get rid of intermediary apparatus, and then try for something cheaper than the oxidation of carbon. But we are wandering from our subject, which is to indicate past, and hope for as rapid progress in the immediate future. The new president is Prof. W. H. Flower, F.R.S., whose address will probably deal with physiographical subjects rather than with experimental physics.

LITERATURE.

Modern Views of Electricity. By OLIVER J. LODGE, D.Sc., LL.D., F.R.S., Prof. of Experimental Physics in University College, Liverpool. With illustrations. Macmillan and Co., 1889.

II.

We have stated our opinion that Dr. Lodge is probably the best exponent of these views that could be found; that the views are by no means final, and, like all previous ones, will continually be modified in detail to make them fit to experimental facts. As to what these views are, the reader to grasp fully must study the book. Only a bare outline can be given here. The fundamental notions are given in chapter I., where, in par. 5, page 12, we are told "that electricity behaves itself like a perfectly *incompressible* substance or fluid, of which all space is completely full. That is to say, it behaves like a perfect and all-permeating *fluid*." The next paragraph supposes we are "immersed in an infinite ocean of incompressible and inexpandible all-permeating perfect fluid," and states how we can "become cognisant of its existence" (1) "by being able to pump it out of one elastic bag into another," the electrical analogy being "with an electrical machine charging two conductors oppositely"; (2) "by winds or currents, etc.," the analogy being galvanometry and self-induction; (3) by making vortices and whirls in the fluid, and by observing the mutual action of these vortices, their attractions and repulsions; (4) by setting up undulations in the medium. In all these ways we have become acquainted with electricity, but there are material differences, says the author, between the behaviour of a material liquid ocean and the behaviour of electricity. These differences are discussed, and ultimately the conclusion is stated that if the ether (the hypothetical ocean of incompressible inexpandible fluid) and electricity are not

identical, "we can more vaguely say that ether contains electricity as a jelly contains water, but that the rigidity concerned in the transverse vibrations belongs not to the water in the jelly but to the mode in which it is entangled in its meshes." The modern views, then, as propounded by the author, seem to be (1) either that ether and electricity are identical, or (2) electricity is something entangled in the ether like water in a jelly—the latter view being adopted "as a temporary working hypothesis." We must confess that we do not see the great advance upon the old view that electricity was "one of the imponderables." The new view merely says it is a something; the old view said the same. Now, having given the fundamental notions, it is necessary to consider how far electrical phenomena conform to these notions, and here our author is at his best. In chapter II. he treats of the dielectric and Faraday's conception of "lines of force." He points out where Franklin's and Symmer's theories failed, and he admits "a difficulty, not fatal, but sensible, and due to an imperfection in our analogy." Prof. Lodge is an adept at constructing apparatus to assist the reader or hearer in understanding the views he puts forward, and, if we remember rightly, "the mechanical analogy of a metallic circuit" (chap. III.) was first explained at the British Association meeting at Glasgow. This chapter deals with "Charge and Induction," which are explained with the aid of models and diagrams. In the last paragraph the author says: "I have explained thus fully the hydraulic illustration of Leyden jar phenomena, because these constitute the key to a great part of electrostatics. The illustration is not, indeed, a complete or perfect one by any means, but by combining with it a consideration of the endless cord models, and of what I have endeavoured to explain concerning conduction and insulation in general, a distinct step may be gained."

"Think of electrical phenomena as produced by an all-permeating liquid embedded in a jelly; think of conductors as holes and pipes in this jelly, of an electrical machine as a pump, of charge as excess or defect, of attraction as due to strain, of discharge as bursting, of the discharge of a Leyden jar as a springing back or recoil, oscillating till its energy has gone."

"By thus thinking you will get a more real grasp of the subject and insight into the actual processes occurring in Nature—unknown, though these may still strictly be—than if you employed the old ideas of action at a distance, or contented yourselves with no theory at all on which to link the facts. You will have made a step in the direction of the truth, but I must beg you to understand that it is only a step, and that what modifications and additions will have to be made to it before it becomes a complete theory of electricity I am unable fully to tell you. I am convinced they will be many, but I am also convinced that it is unwise to drift along among a host of complicated phenomena without guide other than that afforded by hard and rigid mathematical equations."

"The mathematical theory of potential and the like has ensured safe and certain progress, and enables mathematicians to dispense for the time being with theories of electricity and with mental imagery. Few, however, are the minds strong enough thus to dispense with all but the most formal and severe of mental aids; and none, I believe, to whom some mental picture of the actual processes would not be a help if it were safely available."

"Such a representation I have endeavoured partially to lay before you; and I hope if I have succeeded in making myself at all intelligible, that students of electricity will find it of some use and service."

Chapters IV. to VI. deal with the second part of the subject, viz., "Conduction." Here, again, the subject is considered as agreeing with the jelly permeated view. How the current moves through a conductor is admittedly not known, whether like water through a pipe, or "as a perpetual attempt to set up a strain like that in a dielectric, combined with an equally perpetual breaking down of every trace of that strain. Four things are known with certainty: (1) the wire gets heated, (2) no tendency to reverse discharge, (3) the electricity meets with obstruction, and (4) this obstruction is accurately proportional to the speed of electric travel." Coming to conduction through liquids, some seven assertions are made "with considerable

confidence of their truth." For these we must refer to the book itself, or our extracts will become inordinately long—and this is not our purpose—which is practically to state the views put forth in the book, and briefly trace the author's method of showing how the known facts agree or tend to corroborate the views. These assertions, then, are not left to speak for themselves, but such details of knowledge are given as will permit the reader to judge for himself of the confidence expressed. The author points out the difficulties encountered, and believes that further research will show they can be explained by the views put forth. Briefly, then, the aim of these chapters on conduction is to explain the phenomena by reference to electrostatics, so that if the views are correct in the one case, it follows they are so in the other, "for a current, being merely electricity in locomotion, now consist of nothing but a charged body borne rapidly along." "Charge a sphere with either positive or negative electricity, and throw it in some direction; this constitutes a positive or a negative current in that direction. There is nothing necessarily more occult than that. And a continuous current between two bodies may be kept up by having a lot of pith balls, or dust particles, oscillating from one to the other, and so carrying positive electricity one way and negative the other way. But such carriers, as they pass each other with their opposite charges, would be very apt to cling together and combine. They might be torn asunder again electrically, or they might be knocked asunder by collision with others. Unless they were one or other, the current would shortly have to cease, and nothing but a polarised medium would result."

"Instead of pith balls, picture charged atoms as so acting, and we have a rough image of what is going on in an electrolyte on the one hand, and a dielectric on the other. The behaviour of metals and solid conductors is more obscure. Locomotive carriage is not to be thought of in them; but, inasmuch as no new phenomenon appears in their case, it is natural to try and picture the process as one not wholly dissimilar; and this is what, in section 27, we tried to do, with, however, but poor success."

Practical Electric Bell Fitting: A Treatise on the Fitting up and Maintenance of Electric Bells and all the Necessary Apparatus. By F. C. ALLSOP. Illustrated. E. and F. Spon.

This book is an extension of a series of articles written some time since in the *English Mechanic*. It is fairly complete, and up to date, including as it does accounts of the Gassner battery and the Cox-Walker-Swinton magneto call bell. The installation of electric bells may seem a puerile affair, but it must not be forgotten that it is a big business. The manufacture of the apparatus employs many hands, and the export trade is by no means despicable. The literature on the subject is small, and justly so, and its perusal does not need a deep knowledge of mathematics for its true understanding. The plumber and glazier dabble in electric bell work, and are liable to make careless mistakes, due frequently to the lack of the veriest rudimentary knowledge of the subject. A page or two in the manufacturer's catalogue was all the information obtainable till the Americans issued a small book on the subject, which is now followed by the more pretentious one as mentioned above. We shall allow Mr. Allsop to speak for himself, and should advise all who have anything to do with electric bell work to get the book and study it for themselves. In his first chapter the author deals with wiring, and on this makes the following remarks:

"Greater evils, however, result from inferior wiring than from cheap and inferior bells and indicators, as these are at all times accessible, while renewing the wires after a building has been completed and finished can only be done at great expense and trouble; and the use of bad wire cannot but be prejudicial to both buyer and seller. It may be urged that the size of wire herein mentioned is rather large and expensive; but the author is sure that the slight extra expense entailed by its employment will be fully repaid by its greatly increased durability, and the immunity from repeated breakdowns in the communication from the failure of a bad wire."

Then with regard to soldering, he says:

"Too much importance cannot be attached to having good well-soldered joints. The practice of twisting up the joints without a scrap of solder, though it may expedite matters in laying the wires, is too frequently the cause of a gradual falling off in the ringing power of the bells, due to increased resistance being thrown into the circuit by the rapidly deteriorating joints, which, falling off in the ringing, is at once put down by the unexperienced fitter as due to the exhaustion of the battery."

Chapter II. deals with "pushes," "pulls," "contacts," and "switches," of which there are many and varied, the one principle running through each being to ensure good contact. The next chapter deals with bells, relays, and indicators. The latter permits the designer to exercise a large amount of ingenuity, and some of the indicators used in large hotels are worthy of more praise than they receive. Too much is made of the Jensen bell, which, in our estimation for household purposes, possesses no advantages whatsoever. Chapter IV. treats of batteries, those described being the Leclanché, the Fuller bichromate, the Gassner, and the Daniell. We can only quote here the following: "A severe and prolonged test, extending over many years, has proved that for general electric bell work the Leclanché battery has no equal, though in large hotels, etc., where the work is likely to be very heavy, it may, perhaps, be preferable to employ a form of the Fuller bichromate battery. It is very important that the battery employed should be a thoroughly reliable one, and set up in a proper manner, as a failure of the battery causes a breakdown in the communication throughout the entire building, whilst the failure of a push or wire only affects that portion of the building in which the push or wire is fixed. A common fault is that of putting in—with a view to economy—only just enough cells as—when first set up—will do the necessary work. This is false economy, as when the cells are but slightly exhausted the battery power becomes insufficient; whereas, if another cell or two had been added, the battery would have run a much longer time without renewal, owing to the fact that each cell could have been reduced to a lower state of exhaustion, yet still the battery would have furnished the necessary power; and the author has always found that the extra expense of the surplus cells is fully repaid by the increased length of time the battery runs without renewal." Of magneto bells, the author says: "Very often in signalling between two places that are far apart it is preferable, owing to the high resistance of the circuit, to employ a magneto bell and generator instead of a battery. For when the battery consists of many cells the expense becomes an important item, and there is, in addition, the bother of keeping so many cells in order. The magneto generator is generally constructed to furnish its current at a high E.M.F., such as is required on a high-resistance circuit, and in telephony magnetos are used that will easily ring a bell through a resistance of 6,000 to 10,000 ohms. In large buildings, too, it is frequently desired to fit up an extra bell from one part to another without having to run wires to the battery, which may happen to be a long way off, and it is here again that a magneto may be employed to advantage. Hitherto, the magneto bell has been but little used in electric bell work, its chief field being in telephony. This was due, of course, to the low resistance of the circuits in bell work as compared to those used in conjunction with telephones; but also in a great measure to the want of a convenient form of generator for fitting in houses; the ordinary form taking up too much room, besides being very unsightly. Several forms, however, suitable for house use, etc., have lately been introduced, and we shall presently describe some of them.

"Magnetos require but little attention to keep them in order. A few drops of oil now and then in the bearings of the generator, and the armature of the well may require a slight adjustment from time to time. Unlike the ordinary electric bell, however, there are no contacts in the magneto, thus no trouble can arise from dirt, etc., getting between them and destroying the connection."

The extracts given will show the author has carefully thought out his subject. The book is illustrated with 150

illustrations and diagrams. Besides the chapters referred to there are others dealing with "Connecting-up," "Detection of Faults," concluding with a short chapter on Portable Sets.

NEW YORK NOTES.

(FROM OUR SPECIAL CORRESPONDENT.)

Electrical Exhibition at St. John's.

Electricity v. the "Almighty Dollar."

Submarine Cables.

The Electric Motor at its Best.

Electrocution.

Dr. Norvin Green and Mr. Wanamaker's little "Mill."

The National Electric Light Convention on "Electrocution."

The 1892 Exhibition, proposed International Electrical Conference.

The Mayor and his little Axe.

NEW YORK, August 9, 1889.

The electrical exhibition recently held at St. John's, N.B., has been a marked success, and has given great impetus to the electrical industries in Canada. The greater part of the space was occupied by exhibitors from this country. A novel feature of the opening ceremony was the firing of a cannon by electricity, from Vancouver, B.C., nearly 3,400 miles distant. Another innovation was the publication of a small paper, entitled *The Electric Era*, which was set up and published twice daily within the exhibition building. The press was run by an electric motor, and the visitors took great interest in the operations.

Yesterday the electric tramway at Newport, the fashionable summer resort for wealthy New Yorkers, commenced making regular trips to the beach. The opening of this road has special interest in view of the strenuous opposition made to the granting of the charter by the wealthy pleasure-seekers who objected to the presence of the rails and cars upon the scene of their daily drives. A committee was formed, representing I forget how many millions of dollars, but all efforts to stop the march of progress were unavailing. Electricity conquered the almighty dollar, and Newport has its electric cars.

The correspondent in this city of one of your contemporaries, in a recent letter, called attention to the interest which has lately been aroused on this side regarding submarine cables. The same paper, a week later, editorially scoffed at the idea of America competing with England in the field of submarine cable manufacture. The Okonite Company, whose wares have had such a phenomenal success, make a considerable quantity of submarine cable for telephone and telegraph work, and a writer in the *New York World* says, in a recent article describing the factory of this company, "from present indications it is only a question of a very short time when foreign competition, even in large submarine cables, will be driven entirely out of our market." Although I scarcely feel so sanguine on this subject as the writer quoted, still it is interesting to note that the Bishop Gutta-percha Company, of this city, have recently manufactured and shipped to Vancouver 40 miles of submarine cable. This cable is to go to the Hawaiian Isles, and will be the first section of a system of some 400 miles to connect up the various islands of the group. Messrs. Bartholomew and Baker hold the sole concession for 10 years, and will also receive a substantial cash subsidy from the Hawaiian Government. A company has been formed, styled the Hawaiian Pacific Cable Company.

The electric motor is making rapid strides, and is fast coming into very general use. One of its most grateful functions at this season of the year is the operation of the little fans which raise currents of cool air in shops, offices, and restaurants provided with electric light circuits. An installation of motors just completed, and which merits attention on account of various novel features, is that of the Globe Tobacco Company, of Detroit, Michigan. Seven Eddy motors, varying in capacity from 1 to 15 h.p., are placed in different parts of the building, in substitution of the lines of shafting and connecting belts previously employed. The motors, with one exception, are placed on

platforms hung from the ceiling, no floor space being used. Each motor drives its own set of machinery, independent of all the rest. The seven motors aggregate 42 h.p., and nearly all work to their full capacity, but owing to the intermittent character of the work the total current drawn from the dynamo never exceeds 20 h.p., and averages somewhat less. The current is supplied by an Edison dynamo of 50,000 watts capacity, the current having a pressure of 225 volts at normal speed. Current is also furnished by this machine for lighting the building, incandescent lamps being placed in pairs in series.

Public interest in the electrical execution enquiry has waned with the removal of the enquiry to Buffalo. The proceedings here occupied three weeks, and it would puzzle anybody to say how much has been learnt by the enquiry as to killing human beings by electricity in view of the amount of conflicting testimony which has been brought forward. Witnesses for the State (or rather for Edison) incline to the belief that the apparatus bought by Mr. Brown will do its work efficiently and painlessly. Witnesses for Kemmler (or rather for Westinghouse) aver the contrary, and declare that the alternating current, if not exactly healthy and invigorating, is no more deadly than the continuous. The taking of testimony was concluded at Buffalo last Thursday, and the warden of Auburn prison was the last witness called. In the course of his evidence he stated that the contract required Mr. Brown to conduct the execution, but he supposed the law would rely upon himself to touch the button. He admitted that he was scientifically ignorant of the effects of electricity. Mr. Cochran, counsel for Kemmler, who has missed no opportunity throughout the enquiry of manifesting his contempt for expert testimony, suggested that he knew about as much of the subject as ordinary men, and a little more than the experts.

The little "mill" between Dr. Norvin Green, president of the Western Union, and Postmaster-General Wanamaker, anent the one mill per word rate for Government telegrams goes on merrily. Mr. Wanamaker has forwarded to Dr. Green a long-winded letter, in which he upholds the reduction, and says that the Government is able to pay proper rates, and is willing to pay just rates. Dr. Green says that Mr. Wanamaker's letter is not clear, and that one mill per word is emphatically not a just rate. To-day the papers publish Dr. Green's reply, in which he rebuts all Mr. Wanamaker's arguments, and states that for a number of years the Government has been making a saving of 100,000dols. a year below what other customers pay, while it enjoys a preferred service over all other business. Both the technical and general press unanimously condemn and deride the Postmaster-General's action in the matter, and the *Herald* sums up this and others of his measures as a half-a-yard-of-tape policy! For the benefit of uninitiated readers I will explain that Mr. Wanamaker is the Whiteley of Philadelphia.

The tenth convention of the National Electric Light Association met on Tuesday last at Niagara Falls. A special train from New York conveyed some seventy members and friends to the scene of action. There are a number of highly interesting exhibits by prominent electrical firms. Perhaps the most important is that of the Brush Electrical Company, of Cleveland, who exhibit a 150 h.p. motor, claimed to be the largest in the world, and a duplicate of the recently described power plant in the Calumet and Hecla Mine. The principal feature of the second day's session was a paper read by Mr. F. A. Wyman, in which he emphatically condemned execution by electricity. He maintained that the attempt to put to death by electricity is cruel, and said that the man does not live who can tell how much electricity it takes to kill a human being? Mr. Wyman knows a man who took a shock of 2,500 volts and is alive and well. Dr. Otto Moses took up the discussion, and confirmed the author of the paper in his views as to the cruelty of execution by electricity. He stated that where shocks had been received which had not been fatal the victims had suffered agonising pain, and in scarcely any two cases did the accident seem to be accompanied by the same sensations. They were variously described as being like compression of the chest in a vice, being drawn like wire, being hammered to death, being

stuck full of needles, being cut through by a circular saw, being dashed to pieces from a height, and being shaken to death. As a result of the paper and discussion, a resolution was passed to petition the State Legislature for the repeal of the electrical execution law.

Great interest is being taken on all sides in the movement now on foot for holding an international exhibition in New York in 1892, to celebrate the fourth centennial of the discovery of America by Columbus. At the monthly meeting of the council of the American Institute of Electrical Engineers, held this week, Dr. F. Benedict Herzog was nominated as a representative of the electrical industries and recommended to the mayor for appointment to the permanent committee of the exhibition. It was also resolved that an international electrical convention be held in this city during 1892, and that a committee of five be appointed to formulate a plan of organisation.

The Mayor of New York has just returned from taking a fortnight's rest at Lake Saranac, and one of the first things he did on reaching his office yesterday morning was to take up the crusade against the overhead wires. Commissioner Gilroy, of the Department of Public Works, has been instructed by the mayor to remove forthwith all poles and wires now standing (except poles and wires of the electric lighting companies) on Lower Broadway. This order affects about three-quarters of a mile of the busiest thoroughfare in this city, which is embellished on both sides by enormous poles carrying in the aggregate several hundred wires, so it will be seen that Mr. Gilroy has no light task before him.

THE TIMMIS AND FORBES PATENT ELECTRO-MAGNETIC RAILWAY BRAKE.

The whole question of railway brakes is one of such immense importance to engineers, to railway directors, and to the general public, whose safety depends upon the power of bringing a train to a standstill in the shortest space of time possible, that the above subject needs no apology for treatment in our pages. We have seen the present brakes gradually evolved by the principle of natural selection and survival of the fittest, and air-pressure and vacuum brakes seem at present to have the field almost entirely to themselves.

The brake of which we now treat is an attempt to apply the enormous force of attraction which exists between an electromagnet and its armature to supply the necessary force to stop the train. To begin at the beginning, all our readers are well aware of the power of an ordinary horseshoe magnet to attract its armature. It is of course made of steel, and is a permanent magnet. The same result may, however, be obtained by means of a horseshoe magnet made of soft iron of many turns of wire be wound around its limbs in opposite directions so that one of these coils or bobbins is wound in a right-handed direction, while the other is wound in a left-handed direction, and then passing a current of electricity from a battery dynamo or other well-known source round the coils. By this means a much more powerful magnet can be obtained than any permanent one made of steel, the only limit being the size of the wire used for carrying the current and the saturation of the wrought or cast-iron core. The force with which the magnet attracts its armature varies inversely as the square of the distance between the two. The close proximity in which the armature needs to be to the poles of the magnet has always interfered greatly with the extended use of such appliances in mechanical and engineering work, for in almost all cases it is necessary to use a system of levers of the third order so as to increase the stroke to a useful length, thus obtaining only a fraction of the pull of the magnet. This last objection does not apply to the brake in question, for so long as it remains just clear of the wheel when not in use that is all that is required.

It is constructed as follows: A metal ring of channel section, either made of cast or wrought iron, is filled with a coil of wire which is wound into the hollow part of the channel just as a sailor coils a rope. After this is in

position two facing rings are screwed on the edges of this channel of such a width as to overlap its inner edges and partially cover the coils of wire, but so as to leave a space between the two rings, which thus form the two annular poles of the electromagnet.¹

This channel iron with coils and facing rings, which together compose the brake, is suitably fixed upon the axle of the railway carriage or waggon either so that its rings touch the inner face of the carriage wheel or so that they touch its outer face. As a matter of fact, a flat ring of wrought iron is fixed to the face of the wheel, so as to be renewable when worn out, and is made of rather smaller external diameter than the inside of the tyre and can be bolted to the spokes. The brake itself is fixed so as to be free to move in the direction of the length of the axle for a short distance. When a current is caused to pass round the coils of the brake, the outer edge of the channel, and with it the ring fixed to it, becomes, let us say, a north pole, while the inner edge with its ring becomes a south pole. A strong attraction is set up between the face of the wheel and the brake-rings, and as the wheel cannot move, the brake itself is drawn tightly against it, causing enormous friction, which being spread over a large area does not cause undue heating; the brake itself is, of course, prevented from revolving by suitable tie-rods. We shall give, in a future issue, the results of tests made with this new brake, which will be accompanied by detail drawings. The brake itself is now being fitted to trains by Mr. I. A. Timmis, of 2, Great George-street, Westminster, S.W.

STORAGE BATTERIES.*

Mr. President and Gentlemen: I have been invited to address you on the subject of electric traction by storage batteries.

It has been customary for speakers on storage batteries to begin their discourse by apologising for their subject. That day has gone by. The storage battery has no longer any apologies to make.

My purpose, at first, was to give a detailed account of the progress of storage battery traction by going back to 1881, when the first storage battery car was run, and following up the history of improvements from that time to the present. But I have found it impossible to get full and reliable data as to the work accomplished in Paris, in England, or in this country. I wrote to almost all the companies and individuals who have been engaged or are now engaged in storage battery traction to send me full accounts of their experiments and work; but I regret to say that only one responded to my request, and that was Mr. A. H. Bauer, who gave me a very interesting account of his experiments with his storage battery car in Baltimore in 1885-86. The published accounts of the operation and experiments of storage battery cars in Europe are so obviously inaccurate as to be unworthy of reproduction. There is one exception, however, to this, and that is the account given by the Jury of Commissioners at the Antwerp Exhibition of 1885 on the work of the storage battery cars exhibited there; but as you are all more or less familiar with that report I will make no further reference to it. I am, therefore, compelled to confine my remarks to my own observation of storage battery traction. I will not weary you with threadbare information. I once heard a judge tell a loquacious lawyer that he must assume the court knew *some* law. I will assume that you have a pretty general acquaintance with the storage battery in lighting and in traction; but there may be some features, chiefly commercial, that have not come under your observation. My observations cover a period of over three years, during which time the company with which I am associated has directed its talents and energy to the development of storage battery traction. You all, no doubt, appreciate the difficulty of the task—not alone difficulties inherent in the system itself, but difficulties arising from the scepticism

and lack of sympathy, I regret to say, of a very large majority of the electric community. We all know how much scepticism on the part of street railway men has had to be overcome in electric traction of every kind. It has taken a great deal of hard work—of missionary work—on the part of electrical engineers and inventors to bring about present results. But this is not to be wondered at, for there is nothing harder to accomplish than to supersede an old and well-established system. The horse car had plodded along and gathered strength and influence just as it had gathered fares. That influence was widespread and almost all-pervading, for there is hardly a town on this great continent that has not its horse car line. The horse-car system has been spreading for about 50 years, and when it came to be in full and undisputed possession of the field, can it be wondered that those men who had the hardihood to attempt to supersede it should be regarded with more or less suspicion, should be looked upon as pretenders, especially when you consider that the method which they propose to employ was electricity, that dark and mysterious science as many people even now regard it.

Now, the first experiments made with electric cars were calculated to increase this suspicion and to throw dis-favour on electric traction, for it is a characteristic of inventors to be so far carried away by their enthusiasm as to commit great indiscretions in carrying on experiments in public which really should be conducted in private. It was on this account that the early experiments of Daft in 1883, and of other well-known electric engineers in succeeding years, while they created wonder, did not beget confidence. I may say without any invidiousness that two years ago there was not a single electric car run in this country that proved anything more than possibilities.

There were probably two dozen cars being run at that time by the overhead wire system, but so unsatisfactorily that people who went to see them came away shaking their heads with distrust. Now all this distrust has disappeared, and electric traction has grown so fast that to-day there are no less than 100 street car lines in this country that are either running their cars by electricity, or are in the course of introducing the system. Electric traction has beyond all doubt come to stay; as the French say, it has arrived. But the large cities are threatened with the cable. The storage battery proposes, however, to challenge its supremacy.

There is a very general popular misconception of the nature of the storage battery. I suppose that at least 90 per cent. of the public have an idea the storage batteries are nothing but buckets full of electricity. We read in the newspapers from time to time of storage battery cars carrying "tin tanks" filled with electricity. There can be no greater misconception of the nature of the storage battery. The clearest idea I can give you of the energy contained in a storage battery is to compare it with a lump of coal. The source of energy in a battery is identical with that contained in coal. It is merely energy locked up in a number of substances, principally the methods which when set free in a certain manner manifests itself in a certain phenomena we call an electric current. The metal almost universally used in the storage battery is lead in its various forms. In this lead is contained latent energy, the same as in coal, and if we compare the amount of work accomplished by the energy from either source in foot pounds, we will find it to be exactly equal in both cases. Now, the general principles involved in a storage battery are very simple. When we charge a battery from a dynamo or other external source of electricity we are manufacturing lead, and when we discharge a battery through an electric motor or series of lamps, we are simply burning lead. But there is this difference between the action of coal and lead, that whereas coal apparently disappears when burnt, the lead does not, but is converted into sulphate of lead to be converted back to metallic lead again by a reversal of the current; so that the storage battery is alternately burning and reducing lead to and from one of its salts. This is why the storage battery lasts, and does not disappear in the extraction of the energy as coal apparently does. In fact, the storage battery is an ideal illustration of the conservation of force and the indestructibility of matter.

When the storage battery first became known in a pr-

*Mr. Bracken's address, on Storage Battery Traction, before the National Electric Light Association, delivered at Niagara Falls, August 7th, 1889.

tical and commercial form by the experiments of plate in 1859, scientists foresaw for it a great future, and when corporations were formed later on to exploit and introduce the storage battery, the people of Europe, influenced by what might have been considered the extravagant praises of Sir William Thomson and other well-known scientists, put an enormous amount of capital into storage battery enterprises. Almost all of those enterprises, however, proved to be commercial failures; first, because the exploiters were ahead of their time; and secondly, because the public were led to expect more than the storage battery, in its then crude form, would do.

There probably have been few things more difficult to accomplish than to bring the storage battery to its present stage of commercial value. Notwithstanding all that had been written about its nature and characteristics, its treatment, both in its manufacture and use, has, until very recently, been purely empirical. That stage, fortunately, has been passed; so that, with intelligent care, the storage battery to-day is not only a valuable adjunct in lighting, but is becoming a very prominent factor in traction.

The advantages of storage battery traction, assuming that it is practical and economical, are too obvious for me to occupy your time in recounting. The obstacles in the way of success of the system are largely, if not wholly, overcome. The chief of these was the *handling* of the batteries. That was the most difficult and the last obstacle to be overcome by us. Two improvements removed these difficulties. First, the *flexible connector* which enables us to couple up or remove cells with great rapidity; and, secondly, the battery rack, occupying a floor space of 24ft. by 7ft. on each side of the car, wherein we can store a sufficient number of batteries to run from 10 to 20 cars according to its location. This rack represents stall-room for 150 horses, or, say, 6,000 square feet. I regard this rack as the greatest improvement hitherto made in storage battery traction. By its aid, we remove the batteries from a car and replace them by another set in from two or three minutes. Indeed, our cars on Madison-avenue—and I may say here, that we begin to-day to run ten in daily service—have to leave the station on six minutes headway. In the afternoon trips there is but six minutes interval between their arrival and departure, and they all receive their batteries from the same rack. When the car enters this rack its panels are dropped down on either side, and thus form bridges, over which the batteries are withdrawn from and replaced in the car. While this change is being made a competent person inspects the regulators of the car; the motors, gearing, and connections are only inspected once a day, and that at the end of the day's work. You will thus perceive that the great bugbear of how to store the batteries is no longer an element in storage battery traction.

From my observation of our recent work on Fourth and Madison-avenues, now that we are running a number of cars, and under very unfavourable conditions as to station room and the like, I am led to believe that the storage battery car is as free, if not freer, from accident as cars that are run by the overhead system. The motors are, I think, subjected to less trying conditions, owing to the fact that the E.M.F. is always uniform. The batteries never give out on the trip. It is impossible for them to do so, as they leave the station with 35 e.h.p. hours stored in them, and do not consume quite 12 in the round trip of 12 miles. We have never short-circuited the battery in service. When the current required exceeds 150 amperes the battery is automatically cut out. When we used rigid connectors we frequently had difficulty with their breaking, and the flexible connector has, until recently, given us some trouble from time to time by jumping out of position while the car is in service; but with our recent improvements disconnection of the batteries while the car is in service is now rendered almost impossible. For several months past we have had absolutely no trouble from our regulator. In any event there are two on the car, so that if one should fail the car may be operated from the other end. You will thus perceive that the likelihood of accidents or breakdowns is reduced *be. to a minimum.* Our first standard car has run in three months over 6,000 miles and carried over 80,000 passengers *ne ver having missed but one-half a trip* in that time,

and that arose from a bent axle. It has never had an accident or stoppage of any kind while in service. Do not be sceptical at the assertion when I tell you that we have never spent a dollar on that car in the way of repairs or alterations.

At this stage you will naturally ask, how about the life of the battery? I answer that, from our observation, we have nothing to fear on that score. We only ask a life of six months from the positive plates; we know that they will last very much longer than that. The chief reasons why the short-livedness of a storage battery has been so much talked about and feared is that it has, until recently, cost so much to manufacture the battery. Now, the material for your battery you have to buy, in a great measure, but once, for the reason that the discarded battery can be made over new. The raw material in two sets of battery, capable of running a car 120 miles a day, cost, exclusive of the containing jars, about 300dols. Have you machinery and devices requisite for manufacturing this raw material cheaply into a battery? If you have, you need have nothing to fear on the score of economy. It will cost 4,000dols. to purchase enough horses to run a 16ft. car 120 miles a day. It will cost about 1,500dols. to purchase enough battery to do that work. The batteries can be maintained for about one-half what it costs to maintain the horses, and by maintaining I mean replacement as well as feed. This I know for a fact. Can we, then, have any further doubt as to the relative economy of storage battery traction?

Our cars on the Madison and Fourth-avenue line take 1 e.h.p. hour per mile. The road has some long gradients. The grade at Centre-street is over $4\frac{1}{2}$ per cent. and 600ft. in length.

The cost of motive power for a car-day of 75 miles we estimate at 3dols. 40c., as against 7dols. 50c. for horses. Five dollars for 75 miles ought to cover the cost in winter. By motive power we mean the cost of energy at two cents per horse-power hour, and 700dols. per annum for maintenance of batteries and motors. To those who may think that two cents per horse-power hour is a low estimate, we would say that power has been offered to us in New York, to be delivered to us at our station, at the price above named. In towns outside of New York, offers have been made to supply current at lower figures. The more level the road, the cheaper, obviously, will be the cost of motive power. This is more particularly true of the storage battery, which, in excessively steep and long grades, becomes heated. The chemical energy instead of exhibiting itself in the form of electrical energy, exhibits itself in the form of heat, with consequent injury to the battery. Our cars will ascend very steep grades; but we do not deem it economical to attempt grades of more than 6 per cent., and they must be short at that rate. But there are few roads that offer more and steeper grades than the road we are now operating on in New York. Each car has two sets of battery. A set is easily charged in about two-thirds of the time the other is in service. No time is lost in charging, as the battery is automatically put in circuit with the dynamo as soon as it is withdrawn from the car. Now that we have a complete group of cars in service in New York, and hope to follow those by another 10, we will all know more about storage battery traction at our next annual meeting.

OVERHEAD WIRES.

The following regulations for the protection of the public safety, and of the electric lines and works of the Postmaster-General, and of other electric lines and works, prescribed by the Board of Trade under the provisions of the Electric Lighting Act, 1888, have just been issued:

In these regulations the words, terms, and expressions to which by the Electric Lighting Acts, 1882 and 1888, meanings are assigned, shall have the same respective meanings, provided that in these regulations—

"Energy" means electrical energy, and for the purposes of the Electric Lighting Act, 1888, and these regulations, electrical energy shall be deemed to be an agency

within the meaning of the word electricity as defined in the Electric Lighting Act, 1882.

"Conductor" means an electric wire or line used for the supply of energy.

"Aerial conductor" means a conductor which is placed above ground and in the open air.

"Low-pressure conductor" means a conductor in which the difference of electric potential either between that conductor and earth, or between that conductor or any part thereof and any other conductor on the same poles or supports does not exceed 300 volts, if the supply be on the continuous-current system, or the equivalent of 150 volts if on the alternating-current system. A difference of potential on the alternating-current system shall be deemed to be the equivalent of a difference of potential on the continuous-current system, when it produces an equal heating effect if applied to the ends of a thin stretched wire or carbon filament.

"High-pressure conductor" means a conductor in which the difference of electric potential as above described is greater than that of a low-pressure conductor.

REGULATIONS.

1. An aerial conductor in any street shall not in any part thereof be at a less height from the ground than 20ft., or where it crosses a street, 30ft. or within 6ft. of any building or erection other than a support for the conductor, except where brought into a building for the purpose of supply.

2. Every aerial conductor shall be attached to supports at intervals not exceeding 200ft. where the direction of the conductor is straight, or 150ft. where this direction is curved, or where the conductor makes a horizontal angle at the point of support.

3. Every support of aerial conductors shall be of a durable material, and properly stayed against forces due to wind pressure, change of direction of the conductors, or unequal lengths of span, and the conductors and suspending wires (if any) must be securely attached to insulators fixed to the supports. The factor of safety for the suspended wires shall be at least six, and for all other parts of the structure at least 12, taking the maximum possible wind pressure at 50lb. per square foot. No addition need be made for a possible accumulation of snow.

4. Every support, if of metal, shall be efficiently connected to earth, and if of wood or other non-conducting material, shall be protected from lightning by a lightning-conductor fastened to the support along its entire length, and projecting above the support to a height of at least 6in., such lightning-conductor being efficiently connected to earth.

A support shall be efficiently connected to earth when it is connected to metallic mains for water supply outside of buildings, or, where these are not available, to a mass of metal having a total surface of at least four square feet, buried to a depth of at least 3ft. in moist earth, provided that in either case the connecting conductor must possess a mechanical strength, and offer a passage to electrical discharges equal to that of a strand of seven No. 16 galvanised iron wires.

5. Every aerial conductor shall be protected by efficient lightning protectors of pattern approved by the Board of Trade.

6. Where any conductor crosses a street, the angle between such conductor and the direction of the street at the place of such crossing shall not be less than 60deg., and the spans shall be as short as possible.

7. Where any aerial conductor is erected so as to cross any other aerial conductor or any suspended wire used for purposes other than the supply of energy, precautions shall be taken by the owners of such crossing conductor against the possibility of that conductor coming into contact with the other conductor or wire, or of such other conductor or wire coming into contact with such crossing conductor by breakage or otherwise.

8. The maximum working current in any aerial conductor shall not be sufficient to raise the temperature of the conductor in any part to such an extent as to materially alter the physical condition or specific resistance of the insulating covering, if any, or in any case to raise such

temperature to a greater extent than 30deg. of Fahrenheit's thermometer, and efficient automatic means shall be provided which will render it impossible for this maximum working current to be by any accident exceeded to the extent of 25 per centum, even for short intervals of time; and special care shall be taken that the cross sectional area and conductivity at joints is sufficient to avoid local heating, and that the joints are protected against corrosion.

9. Every high-pressure aerial conductor must be continuously insulated with a durable and efficient material, to be approved by the Board of Trade, to a thickness of not less than one-tenth part of an inch, and in cases where the extreme difference of potential in the circuit exceeds 2,000 volts, the thickness of insulation must not be less in inches or parts of an inch than the number obtained by dividing the number expressing the volts by 20,000. This insulation must be further efficiently protected on the outside against injury or removal by abrasion. If this protection be wholly or partly metallic it must be efficiently connected to earth, so, however, as not to cause undue disturbance to other electric lines or works by electrostatic induction or otherwise.

10. The material used for insulating any high-pressure aerial conductor must be such as will not be liable to injurious change of physical structure or condition when exposed to any temperature between the limits of 10deg. F. and 150deg. F., or to contact with the ordinary atmosphere of towns or manufacturing districts.

11. The insulation resistance of any circuit using high-pressure aerial conductors, including all devices for producing, consuming, or measuring energy, connected to such circuit, shall be such that should any part of the circuit be put to earth, the leakage current shall not exceed $\frac{1}{25}$ th of an ampere in the case of continuous currents, or $\frac{1}{10}$ th of an ampere in the case of alternating currents. Every such current containing high-pressure conductors shall be fitted with an indicating device, which shall continuously indicate if the insulation resistance of either conductor fall below the conditions required by this regulation.

12. Every aerial high-pressure conductor shall be efficiently suspended by means of non-metallic ligaments to suspending wires, so that the weight of the conductor does not produce in it any sensible stress in the direction of its length, and the insulated conductors and suspending wires, where attached to supports, shall be in contact only with material of highly insulating quality, and shall be so attached and guarded, that in case they break away it shall not be possible for them to fall away clear of the support.

13. In the case of aerial conductors carrying alternating currents, the two conductors constituting the line and return for any circuit shall be run parallel with each other, and at a distance apart not exceeding 18in.

14. The owner of every aerial conductor shall be responsible for the efficiency of every support to which such conductor is attached, and every support shall be efficiently marked with such mark indicating the ownership of the conductor as the Board of Trade shall approve.

15. Every aerial conductor, including its supports, and all the structural parts and electrical appliances and devices belonging to or connected with such conductor, shall be duly and efficiently supervised and maintained by or on behalf of the owners as regards both electrical and mechanical conditions.

16. An aerial conductor shall not be permitted to remain erected after it has ceased to be used for the supply of energy, unless the owners of such conductors intend within a reasonable time again to take it into use.

17. Every aerial conductor shall be placed and used with due regard to electric lines and works from time to time used or intended to be used for the purpose of telegraphic communication or the currents in such electric lines and works, and every reasonable means shall be employed in the placing and use of aerial conductors to prevent injurious affection, whether by induction or otherwise, to any such electric lines or works or the currents therein.

18. (a) A notice describing every aerial conductor erected or used for the supply of energy shall forthwith, upon receipt of these regulations, be served upon the Postmaster-General, together with a plan showing the mode and posi-

tion in which such conductor is erected. (b) The Postmaster-General, upon consideration of such notice and plan, may require such alteration in the position or mode of erection, or mode of use of such conductor, or compliance with such other conditions as he may think fit, having regard to the protection of the electric lines or works of the Postmaster-General, and any failure on the part of the body or person owning or using, or entitled to use, the said conductor to comply with such requirements shall be deemed to be a non-compliance with these regulations. (c) Any notice required to be served upon the Postmaster-General under these regulations may be served by being addressed to him and left at, or transmitted through, the post to the General Post Office, London, and any notice required to be served on the body or person owning or using, or entitled to use, any aerial conductor may be served by being addressed to such body or person and left at, or transmitted through the post to, their or his office, or last known place of address.

CHICAGO CLUB.

[The following speech, made at the Chicago Electrical Club by Mr. Slattery, summarises what many are thinking.—ED. E. E.]

Mr. Slattery spoke as follows: I do not know whether I can collect my mind enough to address you on the subject assigned to me this evening. However, we will try. Electricity in the nineteenth century is, indeed, a subject well qualified to excite the imagination and the enthusiasm of the most phlegmatic advocate of any branch of the subject. And then as most of us present, the ladies scarcely excepted, are identified with electric appliances of some kind, and brought in daily contact with electric productions of some character, I think we should be by this time fairly well charged. There should be some considerable scope for induced effects. That being so, I trust that through that mysterious channel called induction I may receive such inspiration that I may suitably respond to your eloquent toast. While deliberating upon how to express myself upon this occasion, in imagination I was placed standing upon the monument which modern electric literature has erected, and gazing towards the distant horizon over the landscape, I noticed a distant star, above and toward the zenith. Upon that star I noticed inscribed a name that is associated with the dawn of electric development—Michael Faraday. We all know how this great philosopher was associated with an epoch in the development of electric thought that will prove an everlasting landmark; and the good he did in the world in which he played so prominent a part will for ever remain. Let us for a moment dwell on a few of the grand things this philosopher has given us. Has he not given us his thoughts upon the induction of electric currents, which paved the way to such brilliant results later on? Has he not given us his theory upon the evolution of electricity from magnetism, the grandeur of which thought it is impossible to overrate? Has he not given us his theory upon the nature of electric currents themselves, and electromagnetic action? And notice how closely those thoughts coincide with the utterances of our latest and best men. And above and beyond all, has he not given us his theory of the induction of the current itself, the self-induction, the great bugbear, and yet the saviour in disguise of our modern inductorium electric system? In speaking of Faraday we must not forget other not less prominent discoverers in the great field of electric exploration. Looking again, we notice again in the distant horizon a star, and upon it we see inscribed the name of Arago as associated with the magnetic phenomena, whose thought is embodied in the electric apparatus now in use in every direction. Again we look, and see this time our friend and Faraday's friend—Ampere, whose work is as familiar as a household word. Again we look and we see other stars, and conspicuous among them we notice Sir William Thomson, and also the youthful Silvanus Thompson, and in our own country Elihu Thomson. It is an association of names, a veritable electrical trinity in the great field of electric invention. While we are speaking of those great men, we are quite likely to be

led away from noticing other great men. And in connection with this enumeration we must not forget our Edison, whose practical thought and practical work is visible wherever civilisation finds an entry. And so on. It is easy to enumerate hundreds of names of men who have stamped this century's work with the evidence of their transcendent genius. It is true, indeed, that were it not for these inimitable and indefatigable workers, we should not have the results we have, which have been, practically, to give us a new world in which we live.

We will leave this fanciful monument on which we are standing, and come down to later times, and in as cursory a manner as possible within the limits of a toast we will see how we are profited by the teachings of those early workers. We find machines and motors which have been brought forth from the discoveries of these great men, whirling in every branch of industry on the face of the globe, and revolutionising everything they touch.

Are not our houses illuminated at night with a light rivalling even the noonday sun? Who can say what we shall have in the future? Look at the grand results which have followed from so crude an apparatus as the magnetic needle. And later on we shall see more of the electric motor. Has not our telephone system been so perfected that all we have to do is to reach out our hand and take down the telephone and bring the far-away friend near? It will not be long before we can easily transmit the likeness of our friend as we can a sound wave and our friend at the other end will be perceptible to us, and *vice versa* our likeness will be perceptible to our friend. It is possible that within our time we will see photographic transference. The improvements in electricity will soon enable us to achieve that grand object. And is it not fair to assume that even a thousand miles will not be the limit of speaking distance, and that shortly we shall talk across the great Atlantic? And when this shall be accomplished, I believe will then be fulfilled what has been written that "the lion shall lie down with the lamb." And truly it would seem as if it were a step in that direction when the eagle and the lion shall be brought into such close telephonic association.

Notice, also, to what an extent we have profited since the advent of the storage battery, since in 1863 our friend, Plante, reduced it to a practical basis enabling us to bottle our electricity as we do our wine, and with as much ease and facility to draw from either. I really believe that we have scarcely yet realised the grandeur of this invention. I think its great utilities are yet to come. But I think the least of the utilities will be aerial navigation. I believe that electricity will solve the problems in that direction. I believe in the use of the electric motor and the storage battery, and heat and light as applied to aerial navigation.

But I suppose I will be told, speaking of aerial navigation, that we have had quite enough of electric ballooning in the past, and that efforts in that direction are not attended with brilliant results. It is true that it is so. But while in the past we have used gas as a means of acquiring the necessary buoyancy when rising to the necessary altitude, in the future we can dispense with that, and can dispense with the necessity for undue commercial inflation. But, oddly enough, notwithstanding this vast field of knowledge is being brought within our reach, according to the recent utterances of savants we are as far from an understanding of electricity and magnetism as ever. The utterances of Sir William Thomson and William Rowland bring us scarcely nearer the solution of the great problem, and it seems we have to stand aside and bow our heads before an element so subtle, mysterious, and potent, and we can but hope. And in connection with this last word, I am reminded of that beautiful sentiment given to us by Moliere, which I think is appropriate: "Le sperance tout puissant, il peut il sert au moins nous emener a la fin de la vie." There is no doubt we do hope, but we do trust this is not going to be the "hope deferred that maketh the heart sick." And as evidence of that I am further informed that some gentleman in our electric fraternity has been given a very happy inspiration, which brings him close to the solution of what electricity is. And I am informed that magnetism is approaching its solution.

And it is only rational to imagine that it will not be long before we have the rounded-out solution of the problems of the age. And he expresses himself in this way, speaking of electricity. He said: "Water being a parabolic fluid is readily converted into solid manganese nitrate when its coefficient may be received back in the reflected image of the spectrum." Now what follows? You will find that the paleozoic electrical hypothesis naturally seeks a vacuum, which, combining with alcoholic spinal meningitis, causes geometrical confusion in the empyrean of the democratic elliptic. Prima facie, the Hoboken theory must be applied parenthetically and hypothetically, not forgetting to take into consideration the micrometric admeasurements, the semi-incandescence of the resulting equation, together with its possible duration. Now that is plain, for electricity. The other gentleman expressed himself on magnetism. He said the solution of the problem in that direction will be as highly interesting as in the other. He says: "The anticlinal axis of the magnetic meridian, as demonstrated by the differential calculus, from a parallax angle, clearly shows the difference between empyrean voltage and the megohmic conglomerate, algebraically expressed by the equation, $CxR=V$. Hence the linear length of wire in inductive relation to and with an increment of current in a rapidly revolving mass would warrant the belief that the molecular, vibratory, atomic disturbance due to the abscissæ and ordinates of the magnetic curve rapidly rising at a continually accelerating rate, would have a tendency toward tangential inertia in consequence of its specific inductive capacity when elevated above the horizontal components of the plane of the earth's magnetism."

DUBLIN.

THE CORPORATION PROJECT FOR THE ELECTRIC LIGHTING OF THE CITY.

An important and interesting report of the special committee of the Corporation re electric lighting has just been issued, and will be brought up for discussion at the next meeting of the Civic Council. The report opens with a brief statement of the measures taken to obtain the necessary authority for the Corporation to supply electricity for public purposes within certain districts of Dublin, and to the attitude taken up by the Alliance and Consumers' Gas Company in reference to the matter. Next there is a reference to the proceedings down to the period (June last) when Major Marindin held, on behalf of the Board of Trade, an enquiry into the application of the gas company for leave to open the streets of the city for the purpose of laying down pipes and wires for electric lighting. Major Marindin reported on June 17 that in his opinion it was not expedient for the Board of Trade to accede to the request of the gas company, and on June 29 the Board requested information as to whether the Corporation proposed to apply for powers authorising them to supply electricity for private purposes. The reply of the Corporation was that they did intend to apply at once for such powers, and to do so by license rather than by provisional order, thereby avoiding expensive Parliamentary proceedings. All the necessary documents are now lodged, and after the lapse of the period of two months allowed for objections it may be anticipated, the report states, that the Board will be in a position to grant the required powers. Under the license sought, it is proposed to supply electric power as well as light. The report goes on:

Acting on the lines laid down in the report, No. 107, adopted by the Council on the 29th October last, your committee propose to apply the system of illumination in the first instance in the lighting of the streets and premises from Nelson's Pillar to St. Stephen's Green, and through Dame-street, Parliament-street, Grattan Bridge, Mary-street, and Henry-street. Estimates made by the borough surveyor and Mr. Manville indicate that provision for 10,000 lights will suffice for the existing demand, and that a capital of £43,000 will provide the engines, boilers, dynamos, and all plant, including underground mains of size sufficient to meet the increasing demand which may be anticipated as further improvements are made, and existing patent rights expire, cheapening the supply of electricity. This estimate your committee have raised to £50,000 to provide for buildings and contingencies, but look forward to the exercise of careful economy in respect to any expenditure in connection with this subject. Very valuable information was received by your committee from other cities and towns, but before finally deciding on the plan and estimates your committee named Aldermen Perry and Bryne, and Councillors J. L. Robinson, C.E., and Toole, accompanied by the town clerk and the borough surveyor, to visit some installations in which

success appears to have been obtained. In the result further information of the first importance has been received, and your committee append the report of the results of this inspection. During the past few years electrical science has been rapidly advancing, and several distinct systems of lighting are in successful operation. Your committee are impressed with the responsibility of advising as to which should be adopted for Dublin. In connection with the proposal to utilise the water power at Islandbridge, a system might be adopted by which electricity could be stored during the daytime. In London the Kensington and Knightsbridge Company and the Westminster Company supply electricity by continuous currents partly from batteries and partly from accumulators, and the Chelsea Company do so by currents entirely from accumulators. The capital of these companies is respectively £200,000 (£38,000 paid up and £75,000 promised to be subscribed), £100,000 (£8,000 subscribed), and £100,000 (£33,000 subscribed). Your committee has, however, been struck with the great development of the system by which electricity is supplied at high pressure by alternating currents. This is the system of the London Electric Supply Corporation, the Metropolitan Electric Supply Company (except at Whitehall-place, where the company supply by direct current with storage batteries), and the House-to-House Company. The capital of those companies is respectively, £1,250,000 (£805,000 subscribed, £586,300 paid up), £500,000 (£439,000 subscribed, £131,900 paid up), and £350,000 (£41,600 subscribed). This system is in operation at the Grosvenor Gallery and neighbourhood, and is represented as being so successful that no difficulty has been experienced in the obtaining of the additional capital for the extensive works now approaching completion at Deptford. The sub-committee found the system also working successfully at Eastbourne, Hastings, and Rochester. The exact position of the controversy between the advocates of these systems will be best placed before the Council by the extracts from Major Marindin's report on the recent enquiry in London. He observes that of the scientific witnesses called as to the relative merits of the two systems, the great majority were in favour of the alternating-transformer system for large areas; and among his conclusions it will be noted that he reports "that it must be admitted that the science of electric lighting has now reached a point at which a supply can be made which will be of very great benefit to the public, and that the power of obtaining this supply should be within the reach of all persons who may require it." In view of this opinion, and having regard to the fact that notice has been given by two companies (the Irish House-to-House Electricity Company, Limited, 15, St. Helen's-place, London, and Crompton and Co., Mansion House-buildings, London) of intention to seek powers to supply electricity, it is all the more necessary for the Corporation to maintain its determination to seek and exercise such powers with a view to securing for the ratepayers all the advantages which may be derived from this system of lighting. That there is a demand for the light has been shown not only by the answers received by Councillor Robinson in reply to an enquiry on the subject, but also by the evidence brought forward by the Alliance Gas Company at the recent enquiry in Dublin. The question of the relative cost of gas light and electric light is affected by the necessity for renewal of the incandescent lamps, which are at present expensive patents; but, even including these renewals, the Electric Lighting Committee of the Leeds Corporation consider the cost equal to that of gas at 3s. 5d. per 1,000ft. This is exclusive of the greater advantages attendant on lighting by electricity, such as greater illuminating power, freedom from deleterious atmosphere, cleanliness, and the avoiding of injury to gilding, to soft goods, and to various mercantile wares, at present unavoidable in places where gas is used. On December 5 the Council sanctioned estimates of £500 towards the expenses of maintenance of a system of electric lighting, and £220 for costs of obtaining the necessary powers. An abstract of the expenditure of the committee will be found in appendix C. Your committee now beg to recommend that application be made to the Local Government Board for sanction to the borrowing of £50,000 to carry into effect the scheme proposed, and also beg to recommend that your committee be empowered to acquire a site other than Islandbridge in the event of one being found to be more suitable.

The appended reports of the sub-committee in regard to the electric lighting in Liverpool, Bradford, Leeds, Sheffield, Eastbourne, Rochester, Kensington, and other places, as well as the extracts from Major Marindin's report upon the different systems of supplying the electricity, supply much valuable information, and will largely assist the determination of the question. The original idea of the Corporation was to supply electric light for public lamps within a certain area, using water power available at Islandbridge, and erecting plant at a cost estimated at about £5,000. The scheme now submitted involves the raising of a loan of £50,000 to carry out electric lighting for private as well as public purposes. The question raised is one of great consequence to the citizens, and no doubt it will receive full and deliberate discussion in the Town Council before a decision is arrived at. The committee

appear to have gone very thoroughly into the matter, and whether the recommendation will be adopted or not it will not be denied that they have very ably discharged their task.—*Freeman's Journal*.

NEW COMPANIES REGISTERED.

Chili Telephone Company.—With a capital of £250,000, in shares of £5 each, this Company has been formed for the purpose of acquiring and extending the property and business, in the Republic of Chili, of the West Coast Telephone Company. That company is an American corporation, which commenced its business in Chili in the early part of the year 1885. According to the latest advices there were 2,187 telephones in use, of which 1,084 were in Santiago and 466 in Valparaiso. The property of the West Coast Telephone Company has been agreed to be acquired by Mr. Pittman at the price of £150,000 in cash, and by a contract dated July 9, 1889, made between himself and the company, he has agreed to sell to the Company the concessions and property in Chili, together with the plant, material and assets of every description, with the goodwill of the business there, for the sum of £150,000 in cash, reserving to himself the concessions and whatever business there may be in Ecuador and Peru.

Fowler-Waring Cables Company, Limited.—Registered by Paine, Son, and Pollock, 14, St. Helen's-place, E.C., with a capital of £200,000 in £5 shares, of which 300 are founders' shares. Object: to acquire, unite and carry on the business and goodwill relating to the manufacture, dealing in, or sale of electric or other cables, as now carried on by John Fowler and Co. (Leeds), Limited, and by Richard Solomon Waring, at 85, Queen-street, E.C., respectively. The first subscribers are:

	Shares. Ordinary.
W. Fowler, J.P., 43, Grosvenor-square	100
G. Fleming, 9, Billiter-square, E.C.	100
J. S. Gathorne-Hardy, M.P., 2, Cadogan-square, S.W.	100
W. Chamberlain, Harborne Hall, Birmingham	100
Colonel J. T. North, Eltham	100
R. W. Eddison, Steam Plough Works, Leeds	100
R. S. Waring, 85, Queen-street, E.C.	100

There shall not be less than three nor more than seven Directors. The first are the above signatories to the memorandum of association. Qualification, £500. Remuneration, £2,000, divisible.

Johannesburg Electricity Supply Company, Limited.—Registered by Hollams, Sons, Coward and Hawkesley, with a capital of £250,000 in £1 shares. Object: to acquire and take over a concession dated February 23, 1889, in relation to the supply of electric light in Johannesburg and its suburbs, granted by the Government of the South African Republic, and to work and turn the same to account, and to carry on the business of an electric supply company generally. The first subscribers are:

	Shares.
F. H. Morris, 20, Estelle-road, Gospel Oak, N.W.	1
J. Green, 16, Lanhill-road, W.	1
P. J. Purdey, 28, Devonshire-place, W.	1
C. H. Wetherley, 36, Devonshire-road, Forest Hill	1
L. Cousens, St. George's Club, Hanover-square	1
H. Evans, Mortlake-road, Kew	1
W. G. Hughes, 18, Winchester-road, Belize-park	1

There shall not be less than three nor more than seven Directors. The first are Sir Charles Metcalfe, Bart., Sir Douglas Fox, F. Henwood, A. P. Matheson, and Colonel R. Thynne, C.B. Qualification, £100. Remuneration, £2,000, divisible.

CITY NOTES.

Fowler-Waring Cables Company, Limited.—Letters of allotment in this Company have been posted.

Brazilian Submarine Telegraph Company.—The receipts for the week ended August 16 amounted to £4,334.

West India and Panama Telegraph Company.—The receipts of this Company for the half-month ended August 15 were £2,384, against £2,629.

Western and Brazilian Telegraph Company, Limited.—The receipts of this Company for the week ended August 16, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,935.

Devon and Cornwall Electric Light Company.—With the sanction of Mr. Justice Chitty, a third and final return of capital amounting to 3s. 4½d. per share has been declared by Mr. H. T. Edwards, the official liquidator of the Devon and Cornwall Electric Light and Power Company, Limited, and is payable to the shareholders on any Monday at the offices of Messrs. James and Edwards.

Falcon Engine and Car Works.—An extraordinary general meeting of the shareholders of this Company has been held at the offices, 39, Coleman-street, E.C., for the purpose of confirming resolutions passed on the 23rd ultimo, approving of the provisional agreement between the Falcon Car Company and a trustee for the company intended to be formed, to be called the Brush Electrical Engineering Company, for winding-up the Company, and authorising the liquidators to carry into effect the agreement. Mr. Aymor H. Sanderson, who presided, formally moved the adoption of the resolutions, which were seconded by Mr. Duncan, and agreed to.

PROVISIONAL PATENTS, 1889.

AUGUST 13.

12736. **An improved form of insulator for carrying electric wires.** Cornelius Brown, 193, King Edward's-road, Birmingham.
12752. **Improvements in machines for filling secondary battery plates.** Henry Gurney Morris and Pedro Grotjan Salom, 321, High Holborn, London. (Complete specification.)
12760. **Improvements in electric motors for street cars.** Wilber S. Salisbury, 45, Southampton-buildings, London. (Complete specification.)
12772. **Improvements in means or apparatus for the generation and conversion of electric energy.** Angel de Castro, 55 and 56, Chancery-lane, London.
12773. **Improvements in the system of electric locomotion.** Frank Wheeler, 76, Chancery-lane, London. (Date applied for under Patents Act 1883, Section 103, 14th January, 1889, being date of application in the United States.)

AUGUST 14.

12815. **Improvements in electro-motors.** Frederik Vilhelm Andersen and John Owen Girdlestone, 70, Market-street, Manchester. (Complete specification.)

AUGUST 15.

12869. **Improvement in apparatus for measuring electric energy.** Arthur Albert Day, 60, Queen Victoria-street.
12901. **Improved means for supporting and separating the plates of electric accumulators.** Rookes Evelyn Bell Crompton, 55 and 56, Chancery-lane, Middlesex.
12903. **Improvements in registering mechanism or counters actuated by electric currents.** Robert Jewell, 23, Southampton-buildings, London.
12906. **Electrolytic treatment of vegetable matters and cereals for the production of starch.** Eugene Hermite, Edward James Paterson, and Charles Friend Cooper, 23, Southampton-buildings, London.

AUGUST 16.

12970. **Improvements in printing telegraph instruments.** John Edward Wright and John Moore, 24, Southampton-buildings, London.

AUGUST 17.

12982. **An improved motion for electrical switches.** Thomas Barton, Amsworth-street, Blackburn.
12998. **Improved electric apparatus for clocks.** Charles Wells, 22, Southampton-buildings, Middlesex.
13001. **Improvements in electric fire alarms.** Henri de Poulpique, 323, High Holborn, Middlesex.
13011. **Improvements in incandescent lamps.** Friedrich Sperling, 37, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1883.

12290. **Galvanic batteries.** Schanschiff. 8d.
13643. **Electric circuit making, &c.** Snelgrove. 8d.
13720. **Lightning conductors.** Varley and Driver. 6d.
14149. **Dynamo electric machines, &c.** Willcox (Bradley). 8d.
- 16681A. **Synchronizing electric motors.** Patten. 8d.

1889.

1421. **Voltaic electric belts.** Sykes. 6d.
6805. **Incandescent gas lighting.** Paget and Kintner. 6d.
9300. **Dynamo electric machines.** Lake (Lemp). 8d.
9376. **Miners' electric lamps.** Harris. 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.	Name	Paid.	Price! Wednesday day!
12 Feb. 1/2	Anglo-American Brush E.L.	—	—
12 Feb. 2/0	— fully paid ..	—	—
14 Nov. 0/4½	Con Telephone & Main ...	1	2
27 July 10/0	India Rubber, G. P. & Tel.	10	19½d.
.....	House-to-House	4½	4½
.....	Metroptn Electric Supply	—	2½
.....	London Electric Supply ...	5	3½
.....	Swan United	3½	4½
12 July 12/0	Telegraph Construction ...	12	43½
2 July 6/0	— 6%, 1889	100	105
29 Nov. 5/0	United Telephone	5	15½

NOTES.

Bermuda Cable.—We understand the construction of this cable has commenced.

Indian Telegraphs.—A telegraph line has been completed to Gulmarg, where a station is now established.

Cheadle.—A notice of the Brush Company of their intention to apply for a provisional order has been opposed by the Cheadle Local Board.

Ashton.—The General Purposes Committee of the Ashton (Lancs.) Town Council are to consider the question of the applications for electric light.

Newcastle.—The Brush Company are expecting to get their Mordey alternators in the new central station at Newcastle ready for the visit of the British Association on September 12.

Book Received.—"The A. B. C. of Electricity," by Wm. H. Meadowcroft, which has the advantage of having the endorsement of Edison that the book has impressed him favourably.

Sale by Auction.—As will be seen from our advertisement columns, a sale, as a going concern, will take place shortly (unless sold by private treaty) of an electrical engineering works at Hackney.

Electricians' Watches.—Non-magnetic watches are exhibited at the Birmingham Exhibition by Messrs. Swinden and Sons, who are the firm who obtained the highest certificate from Kew awarded this year.

Telegraphing Plans.—Efforts are being made by the authorities to introduce experimentally in the field a development of the writing telegraph, for the purpose of telegraphing drawings, plans, or maps to distant points.

Bradford Station.—The new Midland railway station and hotel at Bradford, to be opened about the end of September, will be lighted by the electric light. The installation is being carried out by Mr. Langdon, the company's telegraph engineer.

New Zealand Cable.—A Reuter's telegram from New York, dated last Saturday, says the committee of the San Francisco Chamber of Commerce has reported in favour of the laying of a cable to New Zealand, *via* Honolulu and Tutuila, at a cost of 10,000,000dols.

Corporation Central Stations.—We learn that the Huddersfield Corporation has followed the example of Manchester and Bradford, and decided to adopt the electric light in their city. The same action is being suggested for Leeds. Sheffield is also expected to follow in the same steps.

Birmingham Electric Tramcars.—The arrangements for the introduction of accumulator cars on the Birmingham tramways are progressing very satisfactorily. The relaying of the Bristol-road route for their use is now practically completed, and it is hoped to begin running some of the cars before very long.

Newcastle-on-Tyne.—Many of the members of the British Association are interested in good telephonic work, and may be able to prevail upon the Post Office authorities to permit a visit to the Newcastle exchange. If they go to the exchange, we can promise them that they will come away satisfied with the manner in which the work has been carried out.

Gas-Electrics.—From the directors' report to the shareholders of the Partick, Hillhead, and Maryhill Gas Company, Limited, it appears that for the protection of the company's interests, they have served the various local authorities with notice of their intention to apply to the Board of Trade for a provisional order.

British Association Handbooks.—The official handbooks of the British Association are now issued. The official guide "Industrial Section," is a book of some 250 pages, containing an introduction by Mr. Wigham Richardson, and various articles by able men on "Newcastle and the Allied Industries." The article on "Electricity" is by the Hon. Charles A. Parsons.

No Electric Railway for Eastbourne.—The Mayor of Eastbourne, in response to a numerously signed requisition, called a meeting last week to consider the advisability and practicability of laying an electric railway to the foot of Beachy Head with a lift to the top of the Head. The meeting was opposed to the project, and the proposal that such a railway was desirable was not seconded.

Catalogue of Engineers' Stores.—Messrs. W. H. Wilcox and Co. have forwarded to us a very complete and well illustrated catalogue of engineers' stores which they supply, including besides the usual belts and tools, vices, hammers, etc., a number of screwing machines for pipes, and a large variety of pulley blocks, hoisting crabs and such like necessities for central station or any other engineering work.

Electric Clock.—An electrical public clock has been invented, by Alfred Speer, of Passaic, N.J. This is a clock with large dial, and mechanism for driving the hands by power applied to their outer extremities, to overcome the resistance of wind, ice, or snow, the mechanism being electrically operated by a step by step movement through pawl and ratchet devices acting upon pinions working into stationary circular racks.

Theatrophone.—Paris ever seeks new sensations, and a telephone by which one can have *soupeons* of theatrical declamation for half a franc is the latest thing to catch their ears and their centimes. This instrument is to be called the theatrophone, and is shortly to be placed on the Paris Boulevards. Anyone, on the payment of the modest sum of 5d., can be put into communication with a certain theatre and listen to the performance for five minutes.

Another Electric Railroad for Scotland.—It is stated that a private company has been formed with the intention of constructing an electric railway from the town of Lanark to Hamilton, the motive power to be obtained from Stonebyres, one of the series of the Falls of Clyde. The object is to afford the people of Lanark a more direct journey to the city *via* Hamilton than by way of Carstairs Junction. The capital, it is said, has already been subscribed.

"Scribner's Monthly."—This periodical is attempting to give information in a popular manner *à la* "Mangnall's Questions," thus: What strength of current is dangerous to human life? Five hundred volts, but depending largely on physical conditions. This puts us in mind of the conundrum: How many ripe apples will satisfy a boy? The answer is made to depend upon how big the apples are, and how many the boy has had before. Better say to both questions: Don't know—too many "ifs" in the matter.

Search Lights for Advertising.—A very large electric search light has been used in one of the streets of

Birmingham for advertising purposes. It is a Gulcher lamp of 25,000 c.p.—one of the largest sizes used—driven by a 10 h.p. engine on the premises; and although the effect at times is grand in throwing the buildings into bright relief, objections have been raised by neighbouring shopkeepers who complain of the dazzling effect blinding the passengers and preventing them seeing the rival expositions of goods.

New Fields for Electro-plating.—Electro-plating of glass and porcelain has been accomplished by M. Hanson, of France. The chief difficulty heretofore has been to obtain a conducting surface to which the metal would adhere. The patentee uses chloride of gold or platinum dissolved in sulphuric ether, to which sulphur dissolved in some heavy oil is added. When warm, this compound is laid on with a brush. The object is then heated until the sulphur and chlorine is completely volatilised, the gold or platinum adhering closely to the surface.

Compressed Air.—The Birmingham Compressed Air Company, according to statements made at their half-yearly meeting just held, are expecting to do work in supplying compressed air engines in Birmingham, in the same manner as those of M. Victor Popp in Paris. We wish them all success in case they attempt it. There is no doubt the experiment has been successful there, and until electric power is distributed direct from electric mains it is possible there will be a considerable outlet for that of compressed air, in spite of the loss by conversion.

Peccavi.—Yes, no doubt our contemporaries revel in their beanfeast, so following their example we chronicle: *Swell at Brighton (loquitor):* "Ah! that seems a merry party. Who are they?" *Ans.:* "Don't know." *Original Party:* "They are going to the Aquarium, h'm? So am I," and he did. *O. P.:* "Who are they, waiter?" *Waiter:* "Why, that's the party of the *Electrical Engineer*, and a jolly lot of fellows they are: they sing well, eat well, and behave well. What more do you want?" "Oh, ah! thanks." Exit of other folks round the corner, disgusted.

Shields.—At the quarterly meeting of Tynemouth Town Council on Tuesday, Alderman Green moved that a special meeting of the Council be convened to consider the subject of the electric light for Shields, and to apply for a provisional order to authorise the Council to supply parts of the borough with the electric light. There was already sufficient plant in the new market, he remarked, to supply the electric light to the whole borough, which was in a far better position than any borough in the neighbourhood. Mr. Whitehorn seconded the motion, which was unanimously adopted.

Late Telegrams.—In answer to Mr. Cobb, in the House of Commons on Tuesday, Mr. Raikes said that 1,600 railway stations were already open for the transaction of telegraph business on behalf of the Post Office, and that this number is constantly increasing. Arrangements already exist whereby, on payment of an additional fee, telegrams can be despatched from telegraph offices after the usual hours when the attention of the transmitting office can be gained, and he had no reason to think that the railway companies do not afford every facility in this respect in cases of emergency.

British Association.—Though the leading note of the British Association meeting, taken from the President, Prof. Flowers' address, will be biological and not physical, several important electrical papers will be read. Among those already promised are: "Heating Effects of Alternate

Currents upon Conduction of Different Metals," by Mr. W. H. Preece, F.R.S.; "Sparkless Electromagnets," and on a "Phenomenon in Electro-chemical Solution of Metals" by Prof. S. P. Thompson; and "Dynos," by Mr. J. Swinburne; and a further paper on the "Electric Treatment of Sewage," by Mr. W. Webster.

A Huge Dynamo Shaft.—Last Friday, at Messrs. Beardmore and Company's Parkhead Forge, Glasgow, another large casting was made for the London Electric Supply Corporation. This was for the shaft of the Ferranti dynamo; this, when finished, will be the largest dynamo in the world. Over 70 tons of metal were run into the mould, which was sunk more than 20ft. into the ground. The casting was of Siemens steel, and when cold will be hollowed to a diameter of 12in. When finished the shaft will weigh about 32 tons. The casting was in every way successful. It will take fully a week for the metal to cool.

A Daft Feeder Railway.—The Daft Company has secured the contract to equip by electricity the Sunbury and Northumberland Railway, U.S. There are to be three motor cars, each of which will be able to draw an additional car. The company will also supply the steam plant and generator, and the working will be under the supervision of the superintendent of the Sunbury division of the Pennsylvania Railroad. The road will be $3\frac{1}{2}$ miles in length, and will be used to transfer all passengers and the mails and luggage between the Pennsylvania Railroad and the Reading Railroad. The road is intended to take the place of the present steamboats.

Wood Casings.—Messrs. Illingworth, Ingham, and Co., of Leeds, Manchester, and Goole, and whose head office for London is at 34, New Bridge-street, Ludgate-circus, have sent us some samples of their wood casings for electric light wires and cables. All of these are of neat and pretty patterns, and many of them have the lids slightly rebated into the bottom casing, making a thoroughly close and satisfactory joint. A sheet of designs of these casings were also sent, and now that so many houses are being wired up we cannot do better than advise users of casings who are requiring new and useful patterns to apply for these samples and designs.

Japanese Electric Companies.—In Japan the problem of making a fair allotment of shares in a public company has been brought to the front through a rush for the securities of local industrial enterprises. The Nippon Electric Light Company of Tokio offered 4,000 shares of 25 yen, or about four guineas, each for public subscription. Applications were received for 12,000 shares, so it had to be arranged that no one living in the district to be served by the company should have more than 50 shares, and that no more than five should be allotted to individuals living elsewhere. That was an eminently fair way of arranging an allotment, but it could hardly be applied to breweries or nitrates.—*Financial News.*

No Continuity.—A consulting electrical engineer (?) was recently called in upon an important work which was required to be of the very best description. This gentleman reported that the work "must have been very badly done—there wasn't even continuity." This completely upset the architect; he rushed off in a cab to the contractors, who he thought justly ought to have known better. To them most excitedly he says, "How's this? We have asked a consulting engineer in to inspect your work, and he says there is not even continuity." "Well," was the

calm answer, "you tell him to come again when we have put the fuses in. What's the name of your consulting engineer?" Name not given.

Semi-Incandescents.—A new semi-incandescent lamp has been invented by M. Henri Pieper, of Liège, and is exhibited at Paris. Two horizontal rods of copper are placed about four millimetres apart, and a thin pointed rod of carbon, placed vertically, rests on the copper rods and forms a connection between them. The current passes between the copper rods through the carbon, which it renders incandescent. The copper rods are mounted on springs, which cause them to rise slightly when the carbon is totally consumed, and bring them against two contact pieces to prevent the breaking of the circuit. From the description, it appears to be a series lamp and possibly in air. We have no data of the efficiency, which if this is the case can hardly be very high.

Madras Tramways.—The Madras Tramway Order is to come into force at once. The trams may be moved by animal, steam, or any mechanical power, subject to certain regulations. The passenger tolls are not to exceed half an anna per mile for second class, or one anna for the first-class accommodation; but these tolls are subject to alteration at the discretion of the Local Government, provided that no such revision of tolls is to be made without the consent of the promoters until they have distributed by way of dividend an amount equal to interest at the rate of ten per cent. per annum upon the total capital of the company. The construction of the tramways is to be begun within twelve months of the 15th ultimo. We have no information as to what power is decided to be used, but the matter appears to be open.

Leicester.—At a meeting of the Leicester Town Council, held on the 27th inst., the Gas Committee recommended that application be made to the Board of Trade for a provisional order to authorise the Corporation to supply electricity within the borough. Notice had been received from four companies of their intention to apply for similar powers, and the committee came to the conclusion that the best course to adopt for the interests of the town was to maintain their lighting monopoly. Objection was taken to the scheme, on the ground that the Corporation had now plenty of work on hand, but in the result the proposal was adopted *nem. con.*, it being left for subsequent discussion as to whether the power should ultimately be placed in the hands of a company or exercised by the Corporation themselves.

Post Office Surplus.—In a letter to the *Times*, Mr. Henniker Heaton mentions that the profit of the Post Office, which have usually been stated at £3,000,000, was up to March, 1889, within a fraction of £4,000,000. The sixpenny telegram, he also says, now pays. Mr. Goschen has said at Bath that he would part with his life rather than the Post Office surplus. Mr. Henniker Heaton suggests, however, that this Government Department ought not to continue to make further and further profit out of carrying letters. He would not touch the surplus revenue up to three millions, but says, Let it stop there, and let the Parliament carry out the resolution he has proposed: "That all moneys over and above the present Post Office profits be devoted to extending, cheapening, and facilitating postal and telegraphic communication throughout the Empire."

The Dock Strike.—All the world and London has been upset during the past week in its arrangements by the

immense strike extending to some 120,000 men on the docks at the East End of London. Indirectly, it must affect almost everyone, and it is to be hoped by the time this appears the disagreements will be settled. One of the greatest difficulties has been the failure for a time of the coal supply, and one electric works we know was on the point of shutting down and letting its men go idle from want of coal, having failed to get more than basketsful of coke, but happily the coalmen went back without very great delay. Indeed, unless they had done so, even the very presses of the great daily papers would have had to stop, and without doubt electric central stations would have had to have shut down.

✱ **Birmingham.**—The telfer line round the winter garden at the Birmingham Electrical Exhibition is now finished and in order. It seems a good, strong workmanlike job and would do to carry pig iron just as well as passengers. A "living example" of electrical traction of this kind cannot fail to carry great convictions of its utility to the proprietors of works in the Midlands. A scheme is underway for a small projector to be strung up in the winter garden so as to cast a beam of light upon the fountain. Some disappointment has been expressed upon the scattered disposition of the electrical exhibits, which are much mixed up with other ordinary exhibits. It is proposed to alter this to some extent, and that at the same time make meet a social want of the exhibitors themselves, by the establishment of an Electric Club for the benefit of electric men coming to see the show, so that they may be cordially received by those in the exhibition.

Electricity Abroad in Africa.—In connection with the Imperial British East Africa Company, recently incorporated with Royal charter, with capital of two millions sterling, we hear that it is proposed, in view of the hostility evinced by the natives in the major portion of the company's territory, to combine with the German company for the purpose of establishing a gigantic electric lighting station on the summit of Mount Kilimanjaro. A number of arc lights, amounting in the aggregate to 150,000 candles, are to be used, and it is expected that not only will the blaze of light on the tower have the effect of subduing the natives within a range of three degrees, but will materially aid the passage of Mr. H. M. Stanley and Emin Pasha through a dangerous and difficult country. As we have reason to know that this information has not been given to any other journal, we shall be obliged if contemporaries copying it will kindly acknowledge the source.

Rufford Abbey.—Lord Savile has had Rufford Abbey lighted throughout with the electric light, and the work has been completed and is now in working order. The electric light has been introduced into every portion of the abbey, not only for lighting the reception-rooms and bedrooms, but also for the kitchens and servants' departments. A considerable number of lights are also used in the stables and for the new winter garden. Altogether nearly 400 lights are required. The dynamo, driven by a 30 h.p. engine, is placed in the old brewhouse near the stables. A battery of accumulators is also provided, and is used for supplying the lights required both at night and early in the morning. The whole of the work has been designed and carried out by Messrs. Edmundsons, of Great George-street, Westminster, and great care has been taken in introducing the cables and wires not in any way to injure the various decorations, and many of the old

fittings previously used for oil and candles have been adopted for carrying the new lights.

York Tramways.—Mr. Joseph Kincaid is chairman of the York Tramways Company, and will no doubt see that electricity is introduced on their lines in due time. At the last half-yearly meeting, on August 22nd, it was asked, would not electricity be adapted for use in York, and would that motive power be equally economical and safe? The Chairman replied that electricity was, no doubt, equally safe, and one advantage the York Company had was that it had got the authority of Parliament to work by mechanical power, but the directors did not like to move until electrical systems were a little more advanced. In York the traffic was pretty equally divided over the whole system, and if they applied mechanical power at all it would have to be applied over the whole system, so that here it was not quite so suitable as in larger undertakings. The directors, however, would apply their experience to the question, and when matters were more satisfactory they would come to the shareholders.

Accumulator Stations.—It is very evident that if the direct-current system is to play its part in the struggle for existence among the rival systems, the advantages clearly urged for it on the score of safety from breakdown by the employment of accumulators will be one of the chief things in its favour, and a very great one it is. The publication, therefore, of the Electrical Power Storage Company's pamphlet on "Public Supply on the Storage System," is very opportune. In this they urge with force all the advantages which have been fully discussed by their own champions, and by Mr. Crompton and others. Particulars of the special features of the E.P.S. system (King's patents) with automatic switches and regulators as used at the Chelsea central station are fully given; and at the present state of electrical science it cannot be said that intending borough engineers or other authorities have properly read up the subject of central electric supply without perusing this description of the E.P.S. system.

Telegraphing Postal Orders.—Arrangements have now been made for persons in certain of the larger towns of Great Britain to telegraph money orders. The system will commence next Monday. The sender pays the amount, and double the price of the usual order, with also the price of the official telegram and repetition. He also sends an ordinary telegram to the receiver, who obtains the money on presentation of the telegram with satisfactory proof of his identity. The transmission is limited to sums of £10 or under. The ordinary money order forms are used, and the words "by telegraph" are to be across the corner. The institution of this system of telegraphing money will meet a want occasionally found extremely pressing, and as thus arranged can hardly give rise to fraud. The system, if successful, will, no doubt, extend to other towns. For the present, the new orders will be issued from the principal offices in the following towns: London, Birmingham, Brighton, Bristol, Cardiff, Leeds, Liverpool, Manchester, Margate, Newcastle-on-Tyne, Portsmouth, Scarborough, Dundee, Edinburgh, Glasgow, Belfast, Cork, and Dublin.

Exploiting the Colonies.—The tide of supply of electric machinery to the British colonies is, we are glad to see, beginning fairly to set in. The other week we noticed that preparations and negotiations were being made for lighting in Calcutta by Messrs. Crompton. A little

while before we mentioned the central station for Shanghai, which is being constructed by Messrs. Johnson and Phillips. Africa now seems to be seriously taking up the question, and we find a company already formed for the supply and distribution of electric light and power in the latest golden city, Johannesburg, in the Transvaal. Our British engineers cannot too frequently consider that if they wish to rival in any way the remarkable progress in electrical science which has taken place the other side of the Atlantic, they must push to the utmost the supply to that Greater Britain which, as yet, is hardly touched. Canada, for instance, is almost as active as the States themselves in desire for electric light, but obtains most of its plant from the States. At the recent Electrical Exhibition at St. John's, most of the exhibitors were American, although there should be a great field for English goods in our own colony, which, be it remembered, though not so thickly populated, is yet in itself equal in area to the United States. The indications of progress are, however, more satisfactory, now that far-distant consumers become more and more certain that the new industry has developed into a dependable commercial position, and that their desires and requirements, when expressed, can be carefully thought out by thorough experts, the machinery quickly manufactured and sent out, and will serve the purposes for which they are designed with satisfaction when erected.

A Primary Battery Plant.—It is sometimes asked: How should we proceed if the use of dynamo is not feasible and a primary battery is suggested? and data have been sought of successful instances of this kind. Some of these have been given from time to time, and an example comes from Indianapolis, of which it may be interesting to reproduce the particulars, as given in the *Electrical World*. A safety deposit company desiring to use three incandescent lamps in one of their vaults for periods not to exceed 15 minutes, and being unable to secure service from either isolated plant or central station, or extra power to operate a dynamo, requested an electrician, Mr. Reitz, to install a primary battery of sufficient capacity to light three lights of 45 volts, 16 c.p. each. Mr. Reitz called attention to the fact that such an installation would prove neither satisfactory nor economical, and recommended the use of storage batteries, but they were not adopted, owing to the inconvenience of securing current for charging, and for other reasons. So 23 cells were prepared of an improved form of carbon battery, and this has given perfect satisfaction during the past nine months. The round glass jars are 12in. by 8in.; resting on the top of the jar is a cast brass ring supporting 20 carbons, $\frac{5}{8}$ in. in diameter by 12in. long, and a zinc plate 12in. by 3in. by 1in., and weighing 9 $\frac{1}{2}$ lb., which is suspended in a porous cup containing water slightly acidulated (30 parts water to one part sulphuric acid). The solution surrounding the carbons is prepared by adding one and a half pounds of chromic acid to each gallon of water. The cells are cleaned out about once in six weeks. The solution is renewed every three months, and though the battery has been in operation over eight months there is no great decrease in the zinc plates.

The Paris Congress.—The congress at Paris took place last Saturday. M. Mascart was voted as president, and Sir William Thomson as honorary president, and took his place by the side of M. Mascart—an honour to English electricians which they will doubtless appreciate. Mr. Preece was appointed vice-president for England.

The meetings were held at the rooms of the Société d'Encouragement, 44, rue de Rennes. The congress elected to divide the subjects for discussion under four heads: (1) Electrical units, (2) industrial applications, (3) telegraphs and telephones, and (4) electro-physiology. On Monday the congress again met, and organised committees of the sub-sections: First section, M. Lippman, president; M. Pellat, secretary. Second section, M. Pottier, president; MM. Forbes (England), Ferraris (Italy), Fontaine (France), vice-presidents; Hospitalier, secretary. Third section: M. Fribourg, president; M.M. Hughes (England), Banneux (Belgium), vice-presidents; M.M. de la Touanne, Brilenski, and G. Dumont, secretaries. Fourth section: M. Garriel, president; M. Tripiet, vice-president; and M. Broca, secretary. In the third section a paper was communicated by M. Mercadier on telephony. In the second section, M. Crova resumed his researches relating to the creation of a definite unit of light, and, according to reports, giving a strict solution of this problem. After this, M. Bède (Belgium) drew attention to the use of non-condensing engines in an accumulator station. He advocated the use of the steam for heating the stations and keeping them at a normal temperature, or, on the other hand, cooling them by refrigeration in hot climates. Although this strange idea naturally surprised most of his audience, he was listened to with attention and applauded at the end without criticism. The congress continues its sittings. We believe that part of the programme of the Institution has had to be abandoned in consequence of unfortunately clashing with the arrangements of the congress.

X Electric Phantom Ship.—The correspondent of the *Liverpool Courier* gives a vivid account of a somewhat extraordinary accident which occurred through the use of the electric light in the naval manoeuvres. "The 'Warspite,'" he says, "moved out of the harbour steaming slowly; the cross electric flash lights from the new station at Mount Edgecumbe and the battery opposite making the darkness doubly dark from their rapid flashing. Then the sudden withdrawal of their rays produced one of the most wonderful optical effects. By the distribution of the beams of light the image of our ship was projected on the luminous pathway thrown over the water, so that it appeared as if another 'Warspite' of somewhat reduced proportions, but standing out in relief like a real ship, was sailing along on a parallel course to ours, but a little in advance on our port bow, just like the mirage of the desert. Unfortunately this phantom illuminant led to a serious accident as we got abreast of the lighthouse at the end of the breakwater, an accident which but for the promptitude of those in charge of the ship might have been even more serious, and might have resulted in much loss of life. As the 'Warspite' was going out of the Sound a Norwegian barque called the 'Ahti,' some 400 tons burthen, and partly laden with timber, bound from Finland to Plymouth, was coming inside the harbour, we saw her lights steering direct on to us as we rounded the point, and altering course, starboarded our helm, besides going astern full speed. Apparently frightened by the sudden apparition of such a giant monster as we looked, magnified by the various electric lights playing across the water, the master of the barque did the very thing he ought not to have done, ported his helm instead of keeping on his course. The effect of this led to bringing the Norwegian vessel right across our bows, and we struck her just abaft her fore chains on the port side, cutting down her bulwarks and upper works. Happily our ram prow was, through

our deep immersion, at least 17ft. under water, and so it went actually under the barque's keel without damaging the bottom of the craft in any way. But for this, and the slow rate at which we were moving at the time, we would have cut her in two in an instant."

Telephone Electrics.—The following little episode recently passed between the authorities of the National Telephone Company and an electrical engineer who has an office in the City. There are five telephones in the office with one five-line indicator of the usual drop connection pattern in which the fall of the shutter completes the local circuit and rings the bell. The indicator was out of order; being a bad specimen; not only was this so, but it was placed in the sending circuit, so that the difficulty and annoyance due to defective shutters and an almost continuously ringing bell was greatly intensified by the fact that both ends of the circuit contributed to the maintenance of the nuisance. It struck the E.E. in question that as a very simple remedy the indicator and bell might be placed on the receiving circuit only, and he paid a visit to the offices of the National Telephone Company with a view to putting this forward as a suggestion. He saw the manager, who, in a very off-hand manner declined to discuss the matter, and finally asked, with a sarcastic smile, if his visitor proposed to instruct the Electrician, to which the answer was "Yes, certainly: trot him out." When trotted out he proved to be a youth of some 22 summers, who, at first, was inclined to adopt the same domineering air of his principal, and remarked they were perfectly well able to carry out the work of the company themselves. The visitor explained politely that the continuous ringing of the bell was a nuisance, and if the Electrician did not see his way clearly to put the matter right he would do so himself if they would give the necessary authority. The genial youth smiled largely, and asked, Did he think he could do better than the Electrician of the National Telephone. The visitor thought so, if that was a specimen of their ability, but remarked he did not come there either to be offensive or to teach them their business, but merely wanted to remedy the nuisance, and not to argue. The young electrician then asked if knowledge of matters electrical was part of his visitor's acquirements, still preserving his supercilious demeanour. The E. E. meekly replied that he had been a member of the Society of Telegraph-Engineers for 10 years, and had probably done practical work before the Electrician to the Company was born. Whereupon the latter climbed down, and asked if he could kindly have explained how the thing was to be done. A simple diagram was at once drawn, showing the indicator in the receiving-circuit only, but after forty minutes' study on that occasion, and three days' subsequent investigation, he was unable to understand it. Eventually the company sent a man round, cut out the bell in the local circuit, putting five double bells, one to each telephone, on the top of the door of each telephone box, and furnished the office boy with a piece of stick with which to push the shutter up to its place as it fell, so that at the present moment there are five heavenly nuisances instead of one, and a boy has to be continually kept by the side of the indicator with a long stick to make dabs at the shutters as they fall. N.B. to the N.T.C.—Next time any competent person wishes to make a suggestion for the improvement of their notoriously troublesome service they might at least treat it with some attention, and if reasonable, even attempt to understand it.

PARIS EXHIBITION.—V.

THE GLOBE ELECTRICAL AND ENGINEERING COMPANY.

The well-known electrical fittings of Mr. Killingworth Hedges, shown by this Company, occupy an interesting stand near the top of the second avenue. This exhibit consists of an assortment of switches, cut-outs, and mica foils, which, although conforming to the original patented designs, are now considerably improved in the details of the arrangement. The very ingenious apparatus also invented by Mr. Hedges, known as the liquid vortex speed indicator, is shown in improved forms, and the exhibit also contains a number of specimens of carbons.

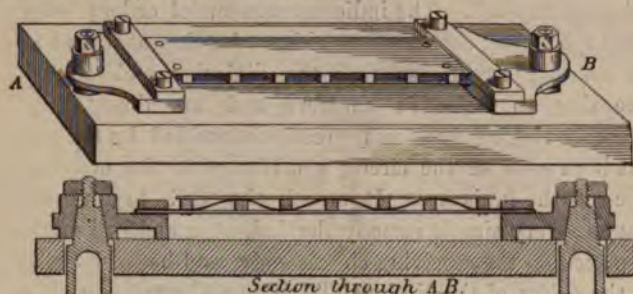


FIG. 2.—Hedges' High-tension Out-out, with Mica Foil.
FIG. 2.—Coupe-circuit à Haut-tension avec Feuille de Mica.

The switches have the same direct-acting loose contact as those which were exhibited at Paris in 1881, but the chance of the spring becoming softened by the accidental development of heat has been obviated, and the contact cannot be left partly on. Enamelled slate bases are used for the switches, and also for all the cut-out frames, with the exception of the circular pattern (shown in Fig. 1), for which plain slate is employed, with bevelled edges, to allow of easy adjustment of the cover.

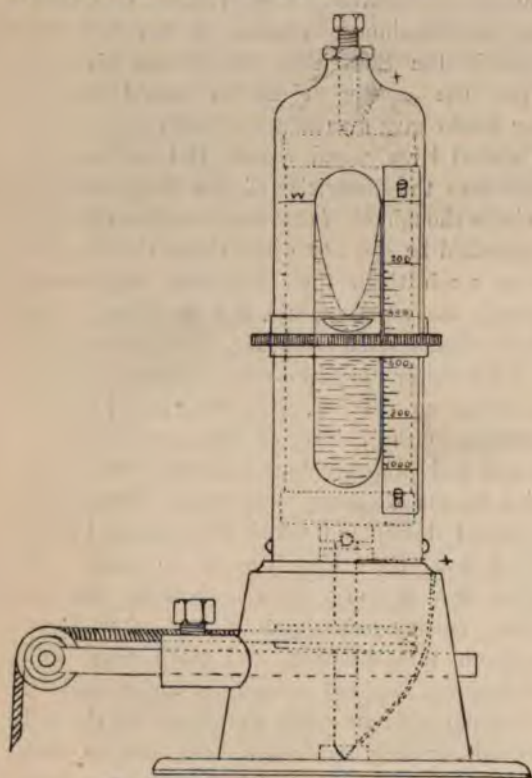


FIG. 4.—Hedges' Vortex Liquid Speed Indicator.
FIG. 4.—Indicateur de Vitesse à Vortex Liquide de Hedges.

The cut-out frame for currents of high E.M.F. is shown in Fig. 2. In these a long strip of tinfoil passes in zigzag fashion over and under pieces of loose fibre washers, the object of this arrangement being to extinguish the arc. The mica case forms a protecting box, and prevents the foil being scattered when the fuse is ruptured. The frames are made in standard sizes to take the usual sizes of cable, and are made with connections of various patterns, which are shown in the illustration. The pattern of Hedges' mica-foil cut-outs which appears to be in most demand is that with the

EXPOSITION DE PARIS.—V.

GLOBE ELECTRICAL AND ENGINEERING COMPANY.

Les appareils électriques bien connus de M. Killingworth Hedges, exposés par ce compagnie, forment une vitrine intéressante vers le haut de la seconde avenue. Cette exposition se compose de différents modèles de commutateurs, de coupe-circuits avec feuilles de mica, qui tout en se conformant aux dessins originaux brevetés, offrent de nombreuses améliorations de détail. On peut voir également différents modèles améliorés de l'ingénieux appareil imaginé par M. Hedges, connu comme indicateur de vitesse vortex-liquide; ainsi que de nombreux spécimens de charbons.

Les commutateurs possèdent le même contact d'action directe libre, que ceux exposés à Paris en 1881, mais on a remédié à l'éventualité que le ressort puisse se trouver



FIG. 1.—Hedges' Cut-out, Circular form.
FIG. 1.—Coupe-circuit Hedges, forme Circulaire.

amoindri par un développement accidentel de chaleur, et le contact ne peut plus rester partiellement établi. On emploie un support en ardoise émaillée pour les commutateurs, en même temps que pour les encadrements des coupe-circuits, à l'exception du modèle circulaire indiqué dans la Fig. 1, dans lequel on emploie de l'ardoise ordinaire à rebords en biseau pour permettre l'ajustement facile du couvercle. L'encadrement du coupe-circuit pour courants de haute tension est indiqué dans la Fig. 2. Dans ceux-ci une longue bande de papier d'étain passe en zigzag au-dessus et au-dessous de morceaux mobiles en caoutchouc, ce qui a pour but d'éteindre l'arc. La boîte en mica forme une enveloppe protectrice, et empêche la feuille d'étain d'être éparpillée quand le coupe-circuit est rompu. Les montures sont faites d'après des modèles-étalons suivant les dimensions ordinaires, et avec des attaches de différents modèles comme on

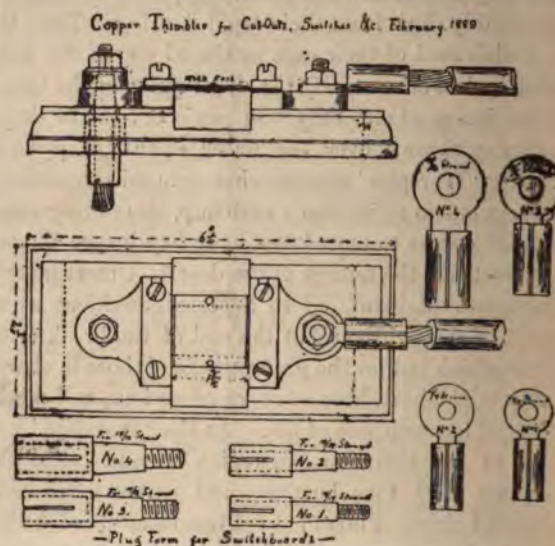


FIG. 3.—Hedges' Main Cut-out, with Mica Foil.
FIG. 3.—Coupe-circuit Hedges à Feuille de Mica.

peut voir sur le dessin. Le modèle de coupe-circuit en feuille de mica de Hedges qui paraît être le plus recherché est celui avec attache à forme conique (Fig. 3), forme qui permet de détacher le cadre du tableau de la distribution, sans toucher aux conduites. Ce modèle a été employé dans l'installation du Club de St. Stephen, des Magasins du Junior Army et Navy, ainsi que dans beaucoup de maisons particulières de Londres.

Les échantillons de feuilles de mica de différents modèles qui sont exposés, montrent les méthodes adoptées pour

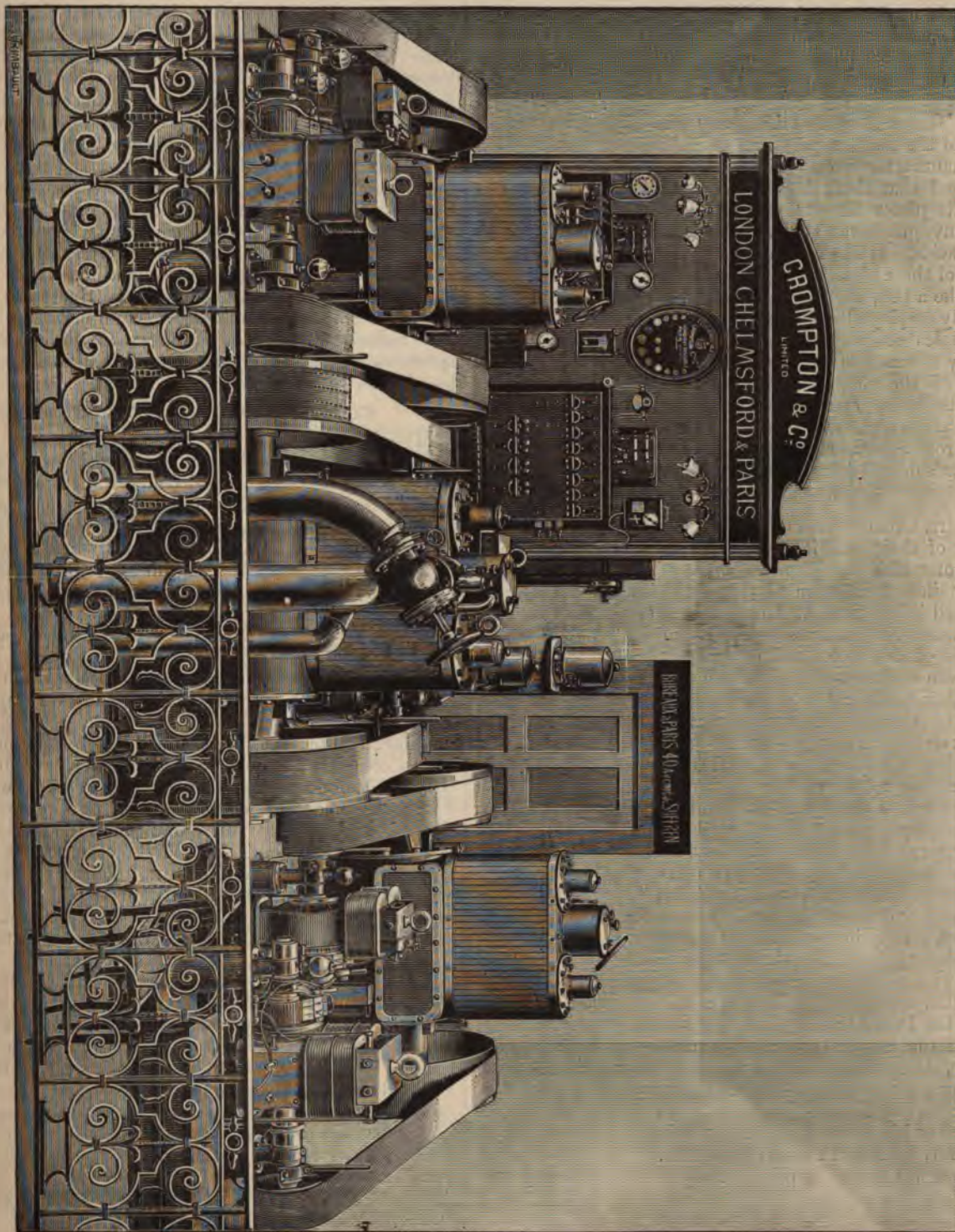
thimble-coned connection (Fig. 3), as this form admits of the frame being detached from the switchboard without disturbing the leads. This design has been employed for fitting up the St. Stephen's Club, the Junior Army and Navy Stores, and also many private houses in London.

The assortments of mica foils of various sizes exhibited show the plan adopted for different currents. For those above 60 amperes, the ends of the fuse, after being carefully intensified with strips of thick tinfoil, are soldered to tinned copper, which, while forming an excellent contact,

différents courants. Pour ceux de plus de 60 ampères, les extrémités du coupe-circuit après avoir été soigneusement renforcées avec des bandes épaisses de feuilles d'étain, sont soudées à du cuivre étainé, qui tout en formant un excellent contact empêche toute chance de fusion qui pourrait provenir d'une attache de contact mal fixée.

Il y a eu de nombreuses demandes de ces feuilles de mica en France et surtout à Paris, où la Municipalité a insisté sur l'emploi des coupe-circuits construits de façon à prévenir toute chance de contact accidentel avec les

View of Messrs. Crompton and Co.'s Stand at the Paris Exhibition.
Vue de la Vitrine de M.M. Crompton et Cie. à l'Exposition de Paris.



also prevents any chance of fusion through a badly-screwed down contact strap.

Many enquiries are being received for these mica foils for use in France, especially in Paris, where the Municipality have insisted cut-outs of such a construction shall be used, that there shall be no chance of accidental contact with the two terminals when inserting a fuse. M. Mors, of the Avenue de l'Opéra, Paris, has used them largely in all his recent installations.

Hedges' vortex liquid speed indicator is now a well

known device. M. Mors, de l'Avenue de l'Opéra, à Paris, les a employées en grande quantité dans ses récentes installations.

L'indicateur de vitesse à vortex-liquide de Hedges, est l'application maintenant bien-connue d'un principe très-simple de dynamique à un usage commercial, et il n'est pas besoin d'en donner ici une description détaillée. C'est simplement l'application de la forme concave que prend tout liquide placé dans un vase soumis à un mouvement de rotation rapide, pour déterminer la rapidité de ce mouve-

known application of a simple principle of dynamics to a commercial purpose, and needs no lengthened description here. In effect, it is the employment of the cup-shaped form which any liquid always assumes when put into a rapidly-revolving vessel, in order to measure the speed of that rotation by the depth to which the hollow in the centre of the liquid extends. This can be accurately read off by means of a scale at the side.

This speed indicator has already been very largely adopted in France, and is used in most of the electric light installations of the French Navy, and at several of the arsenals. The speed indicators of this pattern, which are also exhibited at work at Messrs. Sautter, Lemmonnier, and Cie., and at Messrs. Crompton's stands, are very well finished, and are perfectly noiseless in action, as they are driven direct by means of a gut band instead of by bevel wheels.

The Globe Electrical Company also have an exhibit of some of the more usual sizes of carbons and plates which are manufactured at their works, at Barnsley. We are informed that there is now no necessity to employ cut graphite plates for nitric acid or bichromate work, as this company guarantee their special consolidated plates to resist acids. It is worth noticing that the sonorous property of these plates is very peculiar. When struck they ring like a bell, and, as a matter of fact, they have been actually employed instead of a gong.

Samples of the ordinary carbon-rods supplied to the Trinity House, London, for the British lighthouses, and to many of the English railway companies, are exhibited; and also those manufactured for the Cowles Aluminium Syndicate, which are 2½ in. diameter by 40 in. long. The fluted rods shown are those specially made to Sir James Douglas's design for the large arc lamps in lighthouses.

MESSRS. CROMPTON'S STAND.

Messrs. Crompton and Co. have kindly forwarded to us a view of their exhibit at the Paris Exhibition, the photograph of which we did not receive in time to include in the detailed description of this interesting exhibit which appeared in our issue of August 2nd. The exhibit, as may be remembered, consists of six Crompton dynamos with engines of 300 h.p., and supplies light for the British-American and part of the French and Belgian sections of the Palais des Machines. The space occupied is only 23 ft. by 16 ft. President Carnot, at a recent visit, said: "Vous rendez de grands services avec un espace bien restreint."

Messrs. Crompton and Co.'s interesting and already crowded stand has just been rendered more attractive by the addition of two interesting exhibits; one is a specimen of Crompton's patent armature winding, being a section of armature winding for 1,000 ampere machines, subdivided and twisted to prevent Foucault currents; the other is a very commodious form of potentiometer, devised by Mr. Crompton and manufactured by Messrs. Crompton and Co., Limited. This instrument has a four-meter bridge with multiple switch, so that six separate E.M.F.'s can be compared with a standard Clark cell. The said specimen and apparatus were shown at the conversazione of the joint meeting of the Institution of Electrical Engineers now in Paris, and of the Société Internationale des Electriciens, held Friday, August 23rd, in the rooms of the Société d'Encouragement, where they attracted a great deal of attention. Mr. Crompton himself explained the theory and *modus operandi* of his exhibits to various parties, amongst others being Mr. Edison, Prof. Hughes, MM. Potier, Hospitalier, etc., and was much complimented by these gentlemen.

ment rotatoire, d'après la profondeur de la concavité du liquide; ce qui est facilement indiqué par une échelle placée sur le côté.

L'indicateur de vitesse a été déjà largement adopté en France, et est en usage dans la plupart des installations de la marine française, et dans plusieurs arsenaux. Les indicateurs de vitesse de ce modèle que l'on peut voir fonctionner chez MM. Sautter, Lemmonnier, et Cie., ainsi qu'aux vitrines de MM. Crompton, sont d'un fini admirable, d'une action silencieuse, étant mus directement par une courroie en boyau au lieu de roues en équerre.

La Compagnie Électrique du Globe expose également les échantillons les plus usités de charbons et de lames, fabriqués dans leurs ateliers, à Barnsley, Angleterre. On nous informe qu'il n'est plus nécessaire d'employer des lames en graphite, lorsqu'on fait usage d'acide azotique ou de bichromate, la compagnie garantissant que leurs lames consolidées résistent aux acides. Il est bon de remarquer que ces lames possèdent une propriété sonore particulière. Quand on les frappe, elles résonnent comme une cloche, et de fait, on les a employées en guise de timbres.

On peut voir également des échantillons de crayons de charbon tels que ceux en usage à Trinity House, à Londres, dans les phares anglais, et la plupart des compagnies de chemin de fer, ainsi que les échantillons des charbons fabriqués pour le Cowles Aluminium Syndicate, et qui ont 57 millimètres de diamètre sur un mètre de longueur. Les baguettes cannelées exposées sont celles fabriquées spécialement d'après le modèle de Sir James Douglas pour les grandes lampes à arc des phares.

EXPOSITION DE MM. CROMPTON ET CIE.

MM. Crompton et Cie. ont eu l'obligeance de nous envoyer une photographie de leur exposition à Paris, mais qui nous est arrivée trop tard pour paraître en même temps que la description détaillée que nous avons donnée de cette intéressante exposition dans notre numéro du 2 août.

L'exposition si l'on s'en souvient, se compose de 6 dynamos Crompton avec machines de 300 chevaux et alimente les lampes à arc des sections Anglaise et Américaine, ainsi que la plus grande partie des sections française et belge du Palais des Machines. L'espace occupé n'a que 7 mètres sur 5 mètres.

Le Président Carnot dans une visite toute récente, a dit: "Vous rendez de grands services dans un espace bien restreint."

L'intéressante exposition de MM. Crompton et Cie déjà si complète vient d'être rendue plus attrayante encore par l'addition de deux nouveaux objets; l'un est un modèle d'un enroulement d'armature breveté de Crompton représentant une section d'un enroulement d'armature pour machines de 100 ampères, subdivisé et enroulé de façon à empêcher les courants de Foucault; l'autre est un modèle commode de potentiomètre, inventé par M. Crompton et fabriqué par MM. Crompton et Cie. Cet appareil possède un quadruple pont à curseur avec commutateur multiple de sorte que six F.E.M. distinctes peuvent être comparées à un élément étalon de Clark. Ces deux appareils ont été produits devant l'assemblée de la Société des Electriciens et la Société Internationale des Electriciens qui a eu lieu à Paris vendredi, le 23 août dans la Salle de la Société d'Encouragement, et ils ont été l'objet d'une attention sérieuse. M. Crompton a, en personne, expliqué la théorie et le *modus operandi* de ses appareils à de nombreuses personnes parmi lesquelles se trouvaient M. Edison, Prof. Hughes, MM. Potier, Hospitalier, etc., qui l'ont hautement félicité.

REPORTING PROGRESS.

Piccadilly is up, and the Strand from Charing Cross almost to Wellington-street is up—the workmen are abroad. The Strand, such a typical portion of busily-thronged London, which Charles Lamb loved to watch, glorying in the excess of human activity, is in rucks and heaps as we write, deeply furrowed with troughs in which one sees with astonishment that labyrinth of gaspipes, water-pipes, telegraph and pneumatic pipes, that may well bewilder the enterprising electric light men who essay to add still further to this mass of London's capil-

lary arteries. A glimpse at the underground maze would convince the most sceptical of the desirability for a properly-organised underground conduit, and the more so that the gas companies, from inexcusable negligence, have left not one, but two, three, and sometimes more dead pipes that ought to have been taken out to allow room for more useful connections.

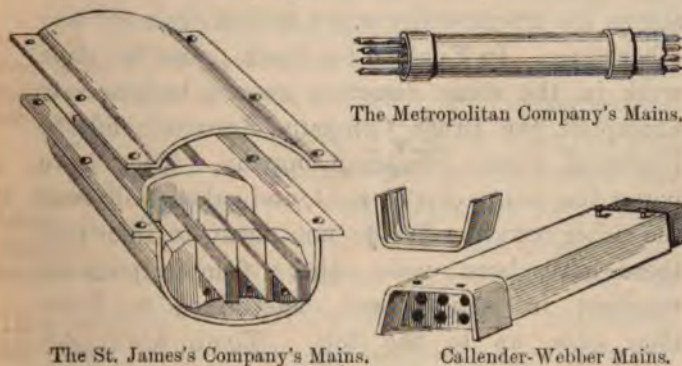
THE STRAND. GATTI'S STATION.

The work of laying underground electric mains in the Strand is in two distinct hands. One portion, extending

from Villiers-street to the Adelphi Theatre, is being done for connection to the central station established at Bull Inn-court by Messrs. Gatti, which at present supplies their own premises. Machinery for a great deal more output than they can use themselves has been put down, and Messrs. Gatti have apparently made arrangements with the Vestry to allow their mains to be put underground, for supplying their friends and neighbours in the vicinity, and a small public central station will thus be established.

The contract, we understand, for the work of the installation has been put into the hands of Messrs. Verity and Sons, Covent Garden. The laying of the cables is being done by Messrs. Callender and Co. with insulated cables upon the Callender-Webber principle, and we give an illustration showing the method of laying.

Troughing, moulded in solid asphalte, is used to carry the cables; holes to the number required, and usually of about 2in. diameter, are run through this solid asphalte, and through these the cables, themselves heavily insulated, are drawn by means of galvanised-iron wires previously let in. The asphalte casing is armoured or protected on three sides by iron plating, which is so arranged as to form a flange to which the next plate is screwed. Protection is thus afforded to the casing on the top and two sides, and danger from the pickaxes of men afterwards digging is avoided. The process of laying is simple, but requires to be well and carefully done. The asphalte casings are butted firmly against one another, the U-shaped jointing piece (shown in the sketch) is placed under the joint, and molten asphalte is run round the joint, forming a completely strong and watertight joint.



The St. James's Company's Mains.

Callender-Webber Mains.

The work in the Strand, it may be readily understood, is one of great difficulty; the whole of the street is a maze of pipes, and the obstacles encountered have been very great. The casings run under and over the pipes in an undulating course across the road, and along the road have to make detours to get to the pulling boxes. Care is, of course, required to keep the curves gentle, so that the cable when it is pulled in does not stick at the bend. Great credit must be given to Messrs. Callender's outdoor manager, Mr. Henry Schiassi, for the smart and workmanlike way in which he has encountered the difficulties and the speed at which he has finished his part of the work. This part of the Strand is now covered over and relaid with wood, and electric light mains will soon now be on tap at Charing Cross. The cable is Callender's 31/11, heavily insulated; the current will be supplied at 110 volts.

THE METROPOLITAN COMPANY.

The Strand, also, from Charing Cross (eventually, we suppose, to the Law Courts) is being threaded with the high-tension mains of the Metropolitan Electric Supply Company, whose station at Sardinia-street will be connected to these mains. The method of laying these mains is of extreme simplicity, consisting of a 6in. iron pipe, run exactly as a gas or water pipe, and through this the highly-insulated small cables will be drawn from manholes or draw-boxes at various points. The positives and negatives will go, it appears, together in the same pipe, and the only difficulty to be feared is to keep the joints watertight.

The Sardinia-street station is now practically completed, and steam has been up, and the dynamos have been run, lighting the station itself, but as yet there are no lights connected on the outside circuit. It is expected to start the outside supply in about two months.

This station, as is well known, is entirely in its inside arrangements in the hands of the Westinghouse Company. This is their first station in England, and they are certainly doing all they can to make the plant a thorough success. The building, lying a little to the back of the Inns of Court Hotel, at the side of Lincoln's-inn-fields, makes a fine large station, with roomy boiler-room, engine-room, and the dynamo-room above these. The boiler-room contains a battery of five Babcock and Wilcox boilers, which are to work at 150lb. pressure, and have just been tested to the pressure of 200 to 250lb. There is room for as many more of these boilers when needed. A tramway for coal-trolleys runs the length of the boiler-room to a large vault under the pavement, through which the coal can be discharged. The boilers are at a lower level than the engine-room, so that the engines received dry steam.

The engines at present consist of six Westinghouse engines, four of 250 i.h.p. and two of 100 i.h.p. Room for seven other engines is provided, and the foundations are ready made. The foundations for all the engines are very well and solidly constructed, and the engine-room is a fine lofty building, with the rows of engines down each side, the belts going up overhead to the dynamos on the floor above. The dynamo-room is equally spacious and lofty, and contain at present four Westinghouse alternating dynamos, working at 1,000 volts and 1,050 revolutions. The switch-house is a very complete and elaborate arrangement, along one side of the room, mounted upon panels of polished block slate, with a clear space behind for connections. All the wires to switches, cut-outs, resistance frames for the fields, and ammeters here converge, the instruments for each machine being placed on polished mahogany boards one above the other, with the switch at easy reach, giving easy manipulation and inspection. We were shown round by the courteous engineer-in-charge, Mr. Andrew S. Mould, who has come over for the Westinghouse Company. He regards this as the finest Westinghouse station yet put up.

THE ST. JAMES'S COMPANY IN PICCADILLY.

The building for the St. James's and Pall Mall Electric Light Company, a plan of which we gave at the time it was up to the ground level, is now finished and complete, presenting quite a handsome appearance if one steps inside the little gateway leading into Mason's-yard, off Duke-street, Piccadilly. It occupies the whole of the centre of the mews, the machinery being down in the basement. The machinery has been started for about two months for partial supply, and about 1,500 lamps are now being run. Two Willans engines and Clark-Muirhead dynamos are now regularly run, and the others will be added shortly. The whole station will supply 20,000 16-c.p. lamps at one time, meaning probably a total number in the district of some 35,000 lamps.

Piccadilly is up for laying these mains, and Messrs. Latimer Clark, Muirhead, and Co. are working hard to get the mains laid without much interruption of the traffic. The mains for this station are quite different from the other two, and the arrangement used is shown in the accompanying illustration. In the first place, the three-wire system is here adopted, and, in the second place, laminated strips of copper are used instead of cables, and, in the third place, the copper is run bare upon insulators without other insulation. Large china insulators of the shape shown are placed in an iron troughing, which can be made watertight, but with outlets to draw off the water of condensation at certain points. The insulators themselves have each a small hole for this purpose under each groove for the mains. A similar but smaller insulator is also slipped on the top of the mains to prevent their accidentally touching the top. The mains themselves consist of plates of copper 2in. by about $\frac{1}{2}$ in. thick, the side mains being composed of 16 strips each and the centre main of eight strips. The voltage of these mains is to be 110 volts, and the distance comprised is within a radius of 400 yards from the station.

It will be seen from these details that central station work in London is at last fairly going ahead, and we may certainly look now for an enormous increase in the amount of electric light ready to be furnished for this winter's season.

THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence ; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices :

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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Specimen copies of the paper will be sent on request.

THE IDEAL PLAN OF SUPPLYING ELECTRICITY.

Upon the introduction of any new idea, before it can become general, as, for example, in the case of the distribution of electricity, two things are essential: first, it must be proved to be practical; secondly, it must pay commercially. It would take too long and occupy too much space were we called upon to prove these statements, but they will probably be taken as nearly axiomatic. Many an experiment is successful in the laboratory which is not practical, that is, it does not succeed upon a large scale like it does upon a small scale. For many years electric lighting has been successful as a laboratory experiment, but it cannot be said to have become practical till within the last few years—some might say the last few months. Large sums of money, and much larger sums in brain power, have been spent to prove the practicability of this system of lighting, and if Edison deserves our praise and the honour of his fellows, it is, perhaps, more from the consummate ability with which he and his friends have maintained and shown the practicability of the system than for any other cause. In England too much praise for their work in the same direction cannot be given to Crompton, the Brush Company, Ferranti, and the Electrical Power Storage Company. They have borne the brunt of the fight, and others will reap the richer reward. We do not mean to infer that there have been none other; firm in purpose, constant in action, and determined to prove their case up to the hilt. There are many such, among whom we might mention, as having done yeoman service, Hopkinson, Howard, Kapp, Elwell-Parker, Esson, Laing, Wharton and Down, Drake and Gorham, Paris and Scott, etc. They have preached and they have practised, fighting quietly, but confidently, through the slough of despond caused by company-mongering, till solid ground has been reached, and willy-nilly those who hate the light most have to acknowledge its practicability. That is one step gained. No retrograde movement can get rid of this fact. It stands permanent for all time. Superior methods of lighting may in the course of ages be devised, but that will not disprove our contention.

Now for the second point. Unfortunately, absolute proof in this direction requires two things, somewhat extended use under varying conditions, and use during a period of time. From the strictly commercial point of view, the data at our command are too limited to act like the shot from a 110-ton gun. Those who cavil, will cavil and dispute without allowing a common-sense view of the case. We cannot determine the sums that have been expended to prove the practicability of the system; sums that once spent have not to be spent again; sums, too, that in the truly commercial

spirit should be distributed over the whole number of years during which such lighting has been or will be used. Such distribution is never made, and therefore the truly commercial part of the business is heavily handicapped during the early years of the industry, and the balance-sheet as shown is by no means a correct one. During the past year or two the sums spent in the direction indicated have largely decreased, and many firms and companies, both in England and America, have been working on a fairly good commercial basis, with the result that in almost every case—we know of no single exception, but it is best to be on the safe side—the commercial balance-sheet has been under the conditions existing satisfactory.

We assume, then, both practicability and commercial success undisputed, and would enquire as to the best means, from the users' point of view, for its general adoption. Artificial lighting is important, both individually and collectively. From the public or collective point of view, streets and public buildings have to be lighted; the individual deals with house, shop, and factory lighting. The principle of free trade holds good here as elsewhere, to buy in the cheapest and sell in the dearest market. The ideal state, then, seems to arrive when one buys of and sells to one's self, and this consummation may be arrived at by the local authorities undertaking the work. In the case of distribution of gas, where this has been undertaken by the local authority, the result has been pre-eminently successful. Supposing, then, the local authorities undertake the distribution of electricity. There is no promotion money to pay, no directors' fees, none of the paraphernalia of a public company, leading to endless troubles and the watering of stock. The capital required stands at the very lowest amount possible, and is obtained at an extremely modest percentage, say on the average not more than three or four per cent. Each householder—that is, each user—is a shareholder getting his return, not, perhaps, from the half-yearly payment of dividends, but from the lower charge made for the light he uses. It is well known that we have always favoured the co-operative system of obtaining the light, and this is an ideal system of co-operation, and really brings the greatest good to the greatest number. The local authority is not a trading concern. Its efforts are not directed in fleecing its customers as much as it dare to swell its profits, but to perform its work in the best possible manner at the lowest rate. If its work produces profit, that profit is distributed to its shareholders—the rate-payers. Under such a system of distribution as this indicated, the customer gets his goods—that is, his light—at cost price. What more can be said in favour of it? But perhaps the more important question is what can be said against it? And to this we fail to find an answer. We see none, though it may be said

that we are colour-blind or so infatuated with the idea that we are incapable of seeing the difficulties. Be it so. Others may succeed where we fail, and till a valid objection is found and promulgated, we shall contend that no better way of supplying the electric current is possible. The troubles arising from contentious Parliamentary proceedings will be obviated, as will those arising from the necessity of breaking up the streets. If, too, the great question of subways under all the principal streets in large towns is ever to be solved, it will have to be solved by the local authority, and we see no valid reason why subways should not be insisted upon in all new streets. The first cost, then, would be the lowest possible, and the value of such subways can hardly be estimated. As time moves on, we are told that the world will become one vast ear; but this will require wires to be laid in all directions, and this multitude of wires must in populous centres go underground. Briefly, then, we conclude that from whatever point of view—except the company-mongers'—the question of distribution is looked at, the best solution is that it be carried out by the local authorities. Whatever may be said in regard to the current for lighting holds good also in regard to the current required for power. Many of our borough engineers and surveyors are taking a deep interest in this, the coming question, and it is to be hoped they will not fail to consider all the bearings of the case, after having done which it seems certain they must come to the conclusions above given.

GAS AND ELECTRIC LIGHTING IN PARIS.

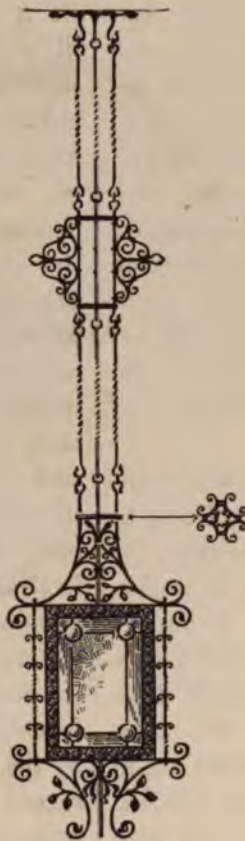
The Paris Gas Company do not intend that the electric lighting companies in that city shall have everything their own way. The fact that some of the large boulevards and the Rue Royale have been lighted electrically has induced the gas company to take steps with a view to showing what results can be obtained from gas lighting by means of improved burners, and for this purpose they approached the Municipal Council for permission to illuminate some of the streets with gas supplied through new kinds of burners. The Council granted permission for the company to light two of the principal streets, and this has just been done. One of the streets is the Rue de la Paix, which was originally lighted by 39 three-light gas jets, each being of a trifle over 10 c.p. These have been replaced by 117 jets of about 58 c.p., the area illuminated being 5,580 square yards. The second instance is that of the Avenue de l'Opéra, which was usually lighted by 189 jets of about 125 c.p., but these have now been substituted by 189 Guibout jets of 105 c.p., and seven lamps of the same system of 260 c.p., the area lighted being 22,690 square yards. These results compare favourably with the electric lighting of the Rue Royale when the area is taken into consideration. As compared with the electric lighting of the Rue Royale, which is lighted by 25 arc lamps of about 672 c.p., the gas lighting of the Rue de la Paix comes out as 1.32 c.p. as against 1.53, and the Avenue de l'Opéra at 1.036 c.p. as against 1.53 c.p. If we now consider the comparative cost of the two illuminants, we find that according to the contracts made by the electric lighting companies with the municipal authorities, the price per carcel (9.8 c.p.) hour for the electric light is fixed at .0073f. for normal lighting, or .55f. per hour for each 720 c.p. arc lamp. The cost for gas lighting in the Avenue de l'Opéra comes out at .0074f. per carcel-hour, and for the Rue de la Paix at .0087f. per carcel-hour, at the usual town price of .15f. per metre of gas. It is evident from the experiments made by the gas company in question, that they are afraid that their business will be ultimately ruined if they do not make practical demonstrations as to what lighting powers can be obtained from coal gas. They will, however, have a very hard fight before them, and will, we believe, in the long run be beaten.

ARTISTIC FITTINGS.—VI.

THE GLOBE ELECTRICAL AND ENGINEERING COMPANY.



PLAN AT A.



PLAN AT B.



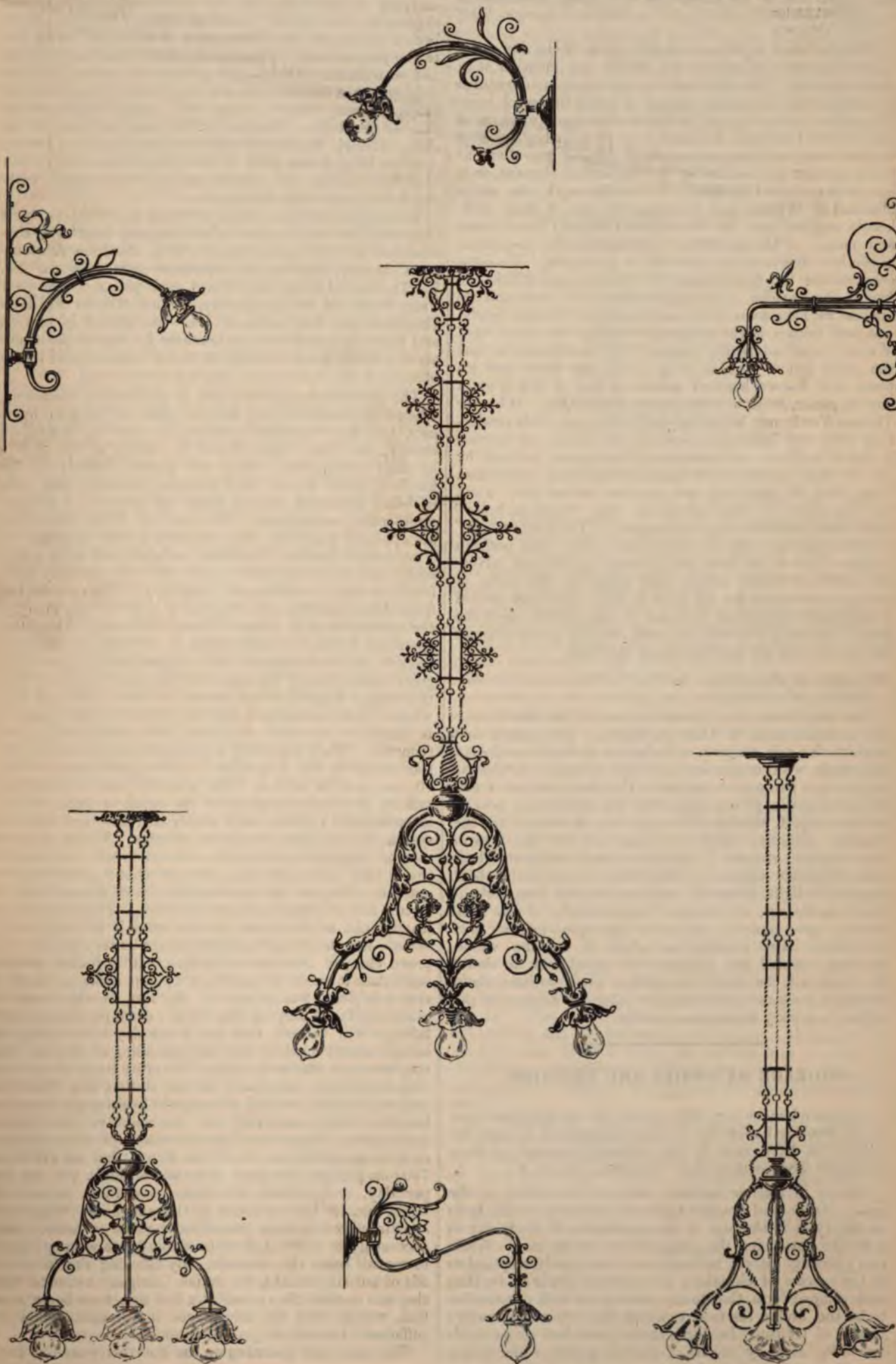
The great increase on the possibilities of supply of electric light have made various electrical engineers look around to enable them to supply the demands which must arise for really artistic fittings, and among these the Globe Electrical Engineering Company have laid themselves out to supply a special class of fitting in hand wrought iron, copper and brass, of very pretty designs. We illustrate herewith some specimens of the fittings now being manufactured, which are designed specially by a member of the Arts and Crafts Guild. The fittings are made both in large and



small sizes, and the peculiar twisted floral work give a very elegant and bright appearance, thoroughly in accord with the special features of the incandescent light.

The Globe Electrical and Engineering Company are making arrangements to exhibit these fittings in a central position in the West End, convenient for private customers or electrical engineers to call and see the actual designs. In the meantime a showroom has been fitted up at their offices at 7, Carteret-street, where those who are interested will be able to inspect them.

ARTISTIC FITTINGS MADE BY THE GLOBE ELECTRICAL AND ENGINEERING COMPANY.



LITERATURE.

The Amber City, or the Adventures of a Steam Crocodile in Central Africa. By THOMAS VETCH. Illustrated. London: Biggs and Debenham.

This the latest of the sensational novels of the day takes a new departure, otherwise we should not mention it in these columns. The tale itself concerns certain adventures in Africa, which necessitate the use of a new design of boat. The author, evidently pretty well acquainted with mechanical and electrical subjects, designs a boat propelled by a double bank of oars, but the exigencies of African travel are, at times, against the boat being on its natural element, so it has to be conveyed by land. To do this work, the aid is obtained of Willans and Robinson for one of their well-known engines, and the Silvertown Company for dynamo and motor. This apparatus is utilised for the propulsion of the boat overland, and the idea is admirable. We must congratulate the firms named for having come within the ken of the novelist. As regards the book itself and its author, we have some faint suspicion that "Thomas Vetch" was well known in the telegraph world on the East Coast. We say "was" advisedly, because our recollection is that the genial fellow "passed away" some time since, and his place now knows him no more; so that if this is not a *nom de plume*, it is a posthumous production. Whoever Thomas Vetch may be, he knows Africa, and if his production does not become the book of the season, our opinion is that it ought to. A number of Portuguese, induced by one of their leaders, enter upon a prospecting expedition. They find all the gold and precious stones they want, but the chief in whose territories they "grub in holes" sends them under escort to Agazulaan—"The Amber City"—where they are kept in durance vile. How their position becomes known, and how their rescuers go through adventure after adventure before they arrive at the scene of action, must be left for the book to tell. The book should be especially interesting to some of our friends upon the Dark Continent, who will no doubt be able to corroborate the accuracy of the descriptions of the book.

The A.B.C. of Electricity. By WM. H. MEADOWCROFT. Manchester: John Heywood.

This small book is of interest because it has the favourable commendation of Thos. A. Edison. The author first explains the volt, ampere, and ohm by hydraulic analogies, then deals with magnetism and how to make an electromagnet or a permanent magnet. The next chapter treats of the telegraph, giving again first the elementary notions of the subject, though, with all due deference to the weighty authority cited, we think not in the best or the simplest manner. Another short chapter deals with telephonic apparatus, after which we are told about the electric light, about arc and incandescent lamps, about dynamos, fittings, and wires. The remainder of the book touches upon motors, and upon batteries—primary and secondary. The information given is, on the whole, accurate, some of the diagrams are good, and no doubt the book will be useful in giving some notions about electrical matters which will not later on have to be put aside as contrary to practical opinion.

STORAGE BATTERIES AND TRACTION.

[In recent issues—viz., July 19 and 26—we gave the views of the Bentley-Knight Co. on this subject, and in reply the Julien Co. have sent us the following account of their successful work with storage batteries.—Ed. E.E.]

Theory in electric traction seems to be a thing of the past. Never had practice followed so closely on the heels of theory as in the case of the application of electricity as a motive power for the propulsion of street cars. While two years ago street railroad men were justly sceptical as to the success of electricity as a motive power in its then undeveloped form, they to-day seem to vie with one another to be the first in the field to adopt this new and attractive means of transit. In 1886, there were but seven roads operating cars by means of electric power, while to-day

there are 109 who are either operating or have roads already in course of construction. It is conceded that an independently propelled car is preferable, for the carrying of passengers in the city streets, to a system dependent on a central source of supply. It has simply been a question to prove that such system could be applied to the propulsion of tramcars so as to be absolutely reliable and economical. The storage of electricity seems to be the only means of obtaining such a result, and it has been the labour of many years to bring this system to its present state of perfection. The first of the standard cars of the Julien Electric Traction Company, operating on the Fourth and Madison-avenue lines in New York City—No. 7—ran over 6,000 miles, and carried over 80,000 passengers without costing one dollar for repairs.

Having proved that a storage battery car could be built that would be reliable, the Julien Company began the construction of 30 (3) cars at the works of the John Stephenson Company, based on the experience gained by car No. 7. The first of these cars—No. 8—was placed on the road June 22nd, and on Wednesday, August 8th, car No. 17—the last of the first group of ten—was placed in service, and have since then run continuously in regular passenger service, to the great satisfaction of the company and to the officials of the Fourth and Madison-avenue road.

The performance of these cars is particularly creditable, when it is considered that they are sent out between horse cars, and are dependent entirely on their self-contained energy, and have never failed to return to the station by their own power. They are placed entirely in the hands of green drivers, who, however, seem to take pride in being promoted from a horse car driver to a position approaching an engineer. The road on which these cars are operated is in every way unsuited to the operation of a mechanical system; the track, switches, and frogs are in many cases of an old pattern, and are very severely worn from the heavy trucking of a large city. The cars are run from the car stables, and owing to a lack of room many of the accessories of an electric system are lacking. The actual operation of these 10 cars marks a new era in street car traction, and it is certainly to be hoped that at a not very great distant period this means of locomotion will be very thoroughly adopted in the streets of New York and elsewhere. Its advantages are too well known to dilate upon; it is simply a question of proving their practicability and economy. Their reliability is proven beyond a question by the record of No. 7, and also by the performance of the 10 cars now in service. The absolute cost of operating cannot, of course, be given as the result of experience to be sufficiently reliable, until the system has been run as a system, for at least a much longer time. In fact, there is not a company running an electric road in America to-day that can more than surmise what it costs them to operate, owing to the uncertainty of the depreciation of motors and overhead construction work. There is not the least doubt in the minds of the officials of the Fourth-avenue line, however, that the storage battery system will prove cheaper than horse traction. It is found on this road that it requires less than 12 h.p.-hours to make a round trip of 12 miles, and at the rate at which current can be produced, varying from 1½ to 2 cents per horse-power hour, it will be seen that for a car day of 75 miles, the actual current required for the propelling of the car will cost but 1d. 50c. at the most. The other items of the cost of motive power, attendance at the station, and depreciation can be calculated by allowing the positive plates of the batteries a life of one year, and the negatives two years; and allowing 10 per cent. per annum depreciation on the motors, regulators, etc., it will be found that we will have 700dols. per car per year, or a total of 3dols. 40c. per car per day, and, adding attendance, say 4dols. as against 6dols. 50c. for horse traction on the same line. When cars are turned out in large quantities, the cost of battery will necessarily be reduced, and the above figure we may expect to see fall below this estimate. By allowing the battery a life of but six months, the Julien Company estimate that they can operate the system at a less cost than horse traction, which, with the advantages it presents, would be sufficient to ensure its general adoption.

The cars now operating on the Fourth-avenue line have

16ft. body mounted on an independent rigid truck with a 6ft. wheel base, on which are placed two 10 h.p. motors; the truck is entirely independent of the car body, and may be removed at any time. The weight of the car mounted on its truck, with motors, gearing, and battery in position, is between six and seven tons. The motors are geared direct, one to each axle, and are readily accessible from the car floor through trap-doors. The battery consists of 108 cells, which are placed in six trays of nine each, on each side of the car. These trays are pushed into the car through the outside panels, under the seats. This battery has a total capacity of about 35 e.h.p. hours. The cars, as operated on the Fourth-avenue line, are geared for a speed of from nine to ten miles an hour on the level, though they can be run much faster for suburban service, when not operated between horse cars. Each car requires from $6\frac{1}{2}$ to 8 h.p. for generating machinery, according to the number of cars in operation. Cars are operated from either end by a regulator. The movable handle is applied by the driver, and no one is better able to run the car than a horse-car driver, owing to his knowledge of the brakes. Putting on and shutting off of the power is learned thoroughly in a few trips.

The regulator used on these cars is a very beautiful feature, the power being applied by different groupings of the accumulators. Thus the variation in speed from the start to 10 miles an hour is so gradual as to be imperceptible. A powerful brake is used on all cars, which, in case of emergency, can be supplemented by the reversal of the motors from the regulator, and the car stopped when going at full speed within one-half its length. Five 16-c.p. incandescent lamps are used to light the car, and a warning gong is also sounded by current from the battery. The truck employed in these cars is to some extent a departure in electric railroad construction, being made of wood, which, in addition to deadening the sound of operation of motors and gearing, takes up all vibration and prevents the loosening of parts, which is found to be so common in cable and other mechanical cars employing iron trucks. The body is supported on rubber cushions, which not only renders their riding most delightful, but prevents all strain on the car body proper in suddenly stopping, or in the rounding of curves. Since these cars have been placed in service, they have never missed but one trip (caused by a broken wheel flange), and there has not been a cent spent upon them for repairs of any kind.

When storage batteries were first introduced for the propulsion of street cars, the question of the handling and charging of the batteries was considered one of grave importance. It will be seen that each car, requiring 216 accumulators, measuring 6in. square and 7in. high, would, in a large installation, be an item of, perhaps, vital consideration, should not the proper means be at hand for their charging and manipulation. One of the most ingenious and attractive features in the Julien system is their battery shifting device. The car runs into the station between two elevators 16ft. long, composed of two shelves, the lower one containing the charged set, while the upper one is used to receive the discharged set when withdrawn from the car. When the fresh set has been put in place through the outside panels of the car the car goes out, and the elevators are raised up between a series of racks, into which the discharged batteries are placed, and a fresh set is lowered, which operation is repeated with each car. The batteries, which are in six trays on each side of the car, make automatic contact with the regulator the moment they are pushed in position in the car, and they in the same manner make contact with the dynamo as soon as they are placed on the shelves. These elevators are run by stationary motors, and the entire change from the time the car enters the station until it is again on the road occupies but three minutes, and while the battery is being changed the regulators and motors are examined. These racks, with motor, etc., occupy a space of but 24ft. by 7ft. on each side of the car, or 336 square feet, which represents the stall room of 135 to 150 horses, or 6,000 square feet. This item of the saving in floor space is one of great importance in large cities where land is at a premium.

The best proof of the favour with which the officials of

the Fourth-avenue road view the operation of these new standard cars, is the fact that they have recently placed an additional order with the Julien Company for a second group of 10 cars, which will doubtless be followed by the entire equipment of the road. Two cars have just been sent to Providence, which will be operated by the Union Passenger Railroad there, and the Pullman Palace Car Company are building 12 bodies, a number of which will be placed in service on the horse-car line in Pullman, Illinois.

NEW YORK NOTES.

(FROM OUR SPECIAL CORRESPONDENT.)

*The National Electric Light Association.
Statistics.
Power from Niagara.
Value of Data to Electrical Industry.
Perfect Central Station.
Remarkable Engines.
Electricity and Insurance.
A Mammoth Central Station.
Traction by Storage Batteries.
Magnet Bell v. Galvanometer.
A Difference of Potential.
Electricians and the 1892 Exhibition.
That Pacific Cable Again.
Electrical Trade with South America.
Dutiable Electricity.
Lightning on the Rampage.
The Board of Electrical Control.*

NEW YORK, August 16, 1889.

The principal event of late in electrical circles is, of course, the semi-annual meeting of the National Electric Light Association, held recently at Niagara Falls. Over 200 members and delegates were present, representing about 60 different towns and cities.

In his inaugural address, President Weeks, in explaining the absence of subways and underground circuits from the topics to be discussed, said that the committee on underground circuits and conductors ask for more time, but it was not to be inferred from this that the subject was being overlooked, or that nothing was being done in the direction of electrical subways. Hundreds of thousands of dollars are being spent on experimental work; but many years must elapse before a complete solution can be reached. This is not very encouraging for the New York companies who have to go underground *volens volens*.

Some interesting statistics, collected by the secretary, were laid before the meeting. The number of arc lamps at present in service in the United States is 237,017, and that of the incandescent lamps 2,704,768; the number of street railroads worked by electricity is now 109, with 575 miles of track and 936 motor cars. The capital now invested in electrical industries amounts to no less than 275,000,000dols.

The Hon. W. C. Ely, of Niagara Falls, delivered an address of welcome to the meeting, and briefly sketched the plan by which it is proposed to utilise the power of the Falls without in any way impairing the beauty of the scenery. This is to be done by a complex system of canals and tunnels, and the estimated results are a discharge of 864,000 cubic feet of water per minute and a yield of 119,000 h.p. At this rate, Edison was not far wrong in saying that "Niagara is the greatest storage battery in the world."

An interesting paper was read by Mr. A. R. Foote on "The Value of Economic Data to the Electrical Industry." Mr. Foote urged the compilation of electrical and mechanical data as being valuable to manufacturers, and of operating, maintenance, and administrative data as being valuable to central station companies. He also pointed out the benefits that proper records of such data would confer upon users of electric service, and upon investors. He also urged that the census of 1890 should have a section for central electric light and power stations, remarking that if the data for it are properly collated and arranged, it will make a marvellous exhibition of the birth and growth of an industry in the short space of one decade. The annals of civilisation may be searched in vain for a parallel to it. At the close of Mr. Foote's paper it was resolved that a committee of five should be appointed to formulate a

system of records and accounts to be kept by central station companies, for reporting the same to the association and for comparing and publishing the data so secured for the use and benefit of the members of the association. Rather a large order you will say, Mr. Editor.

Mr. M. D. Law, of Philadelphia, read a paper on "The Perfect Arc Central Station." Mr. Law evidently has a perfect pair of engines in his perfect station, as he stated that he had a pair of Corliss engines 23 by 48in., 75 revolutions per minute, which had been running day and night for nearly seven years, with an actual cost for repairs of only 25dols., and during that time they were shut down but once on account of breakage, and then only for 10 minutes to disconnect one engine, the other being run with the load of both at increased steam pressure. The discussion hinged solely on the remarkable performance of these remarkable engines, and the gentleman who opened it asked Mr. Law to repeat the paragraph referring to the engines, so as to make sure that he heard aright. Mr. Law stuck to his guns, or rather to his engines, and insisted that they had run 22 hours a day, with a few additional hours' rest on Sundays, for nearly seven years, and only 25dols. were spent on repairs, that expenditure being caused by the breaking of a dash-pot rod.

A highly interesting report on "Harmonising Electrical and Insurance Interests" was read by Mr. P. H. Alexander, and provoked a lengthy discussion, in which several delegates from the insurance companies took part. Mr. Alexander gave the following figures respecting insurance on central stations during the last two years to April 1, 1889: insurance, 6,170,013dols.; premiums, 92,885dols.; losses paid, 32,697dols. The losses amount to but 35.2 per cent. on the premiums paid, which ought to have the effect of reducing the premium on central stations by fully one-half. It was found that 66 per cent. of the central stations figuring in these statistics were built of brick, 22 per cent. of wood, 7 per cent. of stone, and 5 per cent. of material unknown; out of 234 stations, 69 were built expressly and used exclusively for electric lighting purposes.

Messrs. J. T. Henthorn and C. R. Remington read a lengthy paper describing the new central station at Narragansett, Rhode Island. This station covers some 55,000 square feet of land; there are to be two dynamo-rooms, each measuring 60ft. by 200ft. and capable of receiving about eighty 60-light machines. The station is designed so that it may be expanded to an ultimate capacity of some 12,000 h.p. A minute description of the plan and plant of the entire station is given in the paper. It is interesting to note that this mammoth concern, or rather the company which is building it, started but five years ago with only 29 lights.

A paper by Mr. W. Bracken on "Electric Traction by Storage Batteries," evoked no discussion whatever, which is somewhat surprising in view of the interesting data brought forward. The paper was compiled from observations of the work on Fourth and Madison avenues, New York. There are 10 cars in service. The first standard car has run in three months over 6,000 miles, and carried over 80,000 passengers, without an accident of any kind. The batteries can be removed from the cars and replaced by a fresh set in from two to three minutes. The batteries never give out on the trip; it is impossible for them to do so, as they leave the station with 35 e.h.p. stored in them, and do not consume quite 12 during the round trip of twelve miles. The cost of motive power for a car-day of 75 miles is estimated at 3dols. 40c., as against 7dols. 50c. for horses. Five dollars for 75 miles ought to cover the cost in winter.

Mr. C. C. Haskins read a paper on "Station Measuring Instruments." After describing various types of ammeters and voltmeters, he severely condemned the method of testing electric light circuits by means of the magneto bell, and insisted upon the advisability of a daily test with proper instruments.

Other papers were read on "Electric Railways" by Mr. G. W. Mansfield, who brought forward some very instructive and interesting statistics on the rapid growth of this branch of electrical industry, and on the "Electrical Transmission of Power," by Prof. E. P. Roberts.

Mr. E. T. Lynch, of New York, made some valuable suggestions as to the standardising of potential for electric railways, pointing out that the different voltages used by the several systems vary to such a slight extent that a standard potential might easily be adopted, and if this were done the supply of current by central electric lighting stations to the street railway companies would be greatly facilitated. A committee was appointed to endeavour to arrange with the manufacturing companies for the attainment of the desired end. There will probably be considerable difference of potential between the committee and the manufacturing companies.

The Mayor of New York has appointed the committees for the organisation of the 1892 international exhibition. The movement is "booming," and the daily papers devote considerable space to it every day. So far, the electrical interests have been left out in the cold, and have no representative on the committees. Mayor Grant only asked for one name only to represent each industry. No less than five have been put forward by different electrical bodies, and the mayor, unwilling to choose from such an *embarras de richesse*, nominated no one, but left the matter open until the electrical fraternity can agree as to who is to be the man. Undoubtedly the electrical interests ought to be well represented, as it is beyond question that electricity plays a very important, if not the most important, part in the exhibitions of the day.

One of the questions to be discussed at the "Commercial Congress," to be held at San Francisco towards the end of this month is "the establishment of an ocean telegraph cable to Australia *via* the Pacific Islands." Later on in the year there is to be a "Pan-American Congress" at Washington, to be attended by delegates from all central and South American countries.

North America thinks she does not get her fair share of South American trade, and increased mail and cable facilities are proposed with a view of opening up better communication between the two continents. Many electrical manufacturing firms here do considerable business with Central and South America and Cuba, and a number of them find it necessary to issue an edition of their voluminous catalogues in the Spanish language.

The company who propose to erect a power plant at Niagara Falls have asked the Solicitor of the Treasury if, in the event of a contract to light Buffalo by electricity being obtained, the current will be subject to duty or other tax on entering the United States from the Canadian side. It is believed that the Solicitor of the Treasury will evade the question.

There have been several severe thunderstorms lately, and the loss of life from lightning has been abnormally great, no less than 20 deaths from this cause in one vicinity being reported a few days back. Three days ago the Ordnance Office at the United States Proving Ground at Sandy Hook was struck by lightning and totally destroyed by fire; the building was a small wooden structure about 20ft. square, but it contained instruments to the value of 80,000dols., all of which were lost. A large oil tank belonging to a refinery in New Jersey was struck by lightning and set on fire the same afternoon, damage to the extent of 15,000dols. being done.

The Board of Electrical Control met yesterday, and two of the commissioners made a report regarding the best methods of preventing subway explosions, which have been so frequent of late. The report says that the explosions are caused by leakage of gas into the manholes, and recommends that the subways be kept ventilated by blowers and air-compressors, and that the gas companies be compelled to prevent leakage from their pipes. Considering that the soil of New York is thoroughly saturated with illuminating gas, this is rather a large order. The commissioners also suggest the drafting of a Bill for the next Legislature which will confer upon "some municipal board the same control over the streets underground and all underground construction as is at present exercised by the Board of Electrical Control in the case of subways for electrical conductors."

During the month ending July 15th 380 miles of wire and 68 poles were taken down, and the Western Union

Company took down 211½ miles of wire and 25 poles during the same time. During the year ending June 15th 1,495 miles of wire and 2,417 poles were removed.

THE PERFECT ARC CENTRAL STATION.*

BY MR. M. D. LAW.

It has usually been more the rule than the exception that electric light central stations have been located in almost any place that could be had; some old shell of a building would be used, that would have nothing to recommend it except that it was cheap.

In fact, the first station for central lighting purposes was started in San Francisco in a blacksmith's shop, using an old, worn-out portable engine and boiler. The force consisted of one man, who was superintendent, dynamo man, engineer, fireman, trimmer, inspector and lineman; but the price received for the lights would gladden the hearts of the electric light companies of to-day; they were 10dols. per week per lamp, and burned from dusk to midnight, except Sundays. And when I look back to that time of running arc lamps on one wire, with ground return, I am amazed that there were so few troubles in the shape of grounds and fires. Not only was a ground return used, but inside wiring was thought good enough when put up without any insulation, but fastened with wire staples.

There are a great many places even now where bare wires are stapled fast, showing the absolute need of good, competent, fearless inspectors, who will examine every inch of wire in a building, and not be afraid to condemn it if it does not come up to the requirements of safety. Then, again, all inside wiring should be inspected at least once a month.

An electric lighting station should be located as near the centre of the territory to be lighted as possible, but if sufficient ground cannot be obtained at a reasonable cost, then it is better to go a little to one side rather than be crowded for room; for when an electric lighting station is cramped for room, it cannot be handled with economy, as one of the greatest successes of central station work is not only in the simple running of the machinery well, but, when troubles occur in the shape of breakdowns (which are liable to happen in the best regulated station), there should be sufficient room to move the machinery, without taking too much time. In such a case, time is money, for the amount of money allowed in rebates is only a small fraction of the loss, as the reputation of never having the lights out is worth much more than their mere money value. For electric lights are not a success until they can be placed in business houses and halls, having no other method of illumination, without danger of their being suddenly being left in darkness; rather have the machinery and lines in such shape that the lights can be depended upon at all times. This may take a little more money for the construction of the plant, but it will be more than made up in the commercial value of the lights.

An electric lighting station should be built of brick or stone, in a neat, substantial manner, not more than two storeys high, and be as nearly fireproof as possible. One of the important factors of such a station is good ventilation, it being necessary to keep engines, shafting, and dynamos as cool as possible. This not only adds to their life, but their over-heating is a great element of danger to the success of the lights.

BOILER-ROOMS AND BOILERS.

The boiler-room should be located on the ground floor, with plenty of ventilation, making the fireroom cool and comfortable. Everything being in full view and easy of access can be kept clean and in order.

In constructing an electric light station the dynamos and engines are generally placed first, and what room is left the boilers are thrown into without much regard to their economical handling. It is better to have a comfortable fireroom, as the firemen can then remain by the boilers, doing justice to their work. By having boilers in cellars

cramped, or poorly lighted and ventilated places, it makes the men careless, and also detracts from the life of the boilers by corrosion and improper care.

It is found that two-thirds of the steam which is generated in a tubular boiler is made on the shell, and not in the boiler tubes, as supposed. In taking the heated surface of boiler tubes we should only take one-half of the circumference, as the flame only impinges on the upper half of the tubes. With proper setting, flame can be carried the full length of a 30ft. boiler, with ordinary natural draught, using secondary combustion. Automatic dampers should never be used; by their use it is impossible to get proper combustion, as they are either open or closed, besides having the tendency to make firemen careless. An ordinary fireman with hand dampers can fire with not over two pounds variation of steam in a run of 12 hours. When the boilers are working to within three to five pounds of their utmost capacity, the hand dampers are kept partly open, and as the steam varies the damper is changed to suit, therefore always allowing of proper combustion.

For a 1,000-light station there should be twelve single tubular boilers, 48in. in diameter and 20ft. long, with 22 5in. tubes, the shell to be made of ¾in. steel or iron, having a tensile strength of 55,000lb. and 25 per cent. ductility in eight inches.

Double riveted longitudinal seams and first-class workmanship will stand a safe working pressure of 130lb. per square inch, which will give 1,325 h.p. With the Corliss type of engine, carrying 110lb. per square inch, there would therefore be three boilers, which could be held in reserve, that being none too many for safety, and the other nine boilers can be worked very easily, as rapid combustion is the most economical.

ENGINES.

Electric lighting is one of the hardest kinds of work for a steam-engine, the continuous running and the work being thrown on and off instantaneously causing immense strains.

They should be twin engines, connected at right angles, by which we have steadier power than with single engines, because we have the impulse of the steam at every quarter of a revolution. They should be built specially, and have a larger amount of iron in all their parts than is used in an ordinary commercial engine, so that in times of trouble they can be forced for a short time beyond their ordinary load.

For a 1,000-light station there should be two 23 x 48in. twin engines, running at a speed of from 70 to 80 revolutions. With this number and size of engines there will be a reserve of one engine, as the three engines will easily carry the load of 1,000 lights with economy.

It is a settled fact that the Corliss type of non-condensing engines, properly constructed and handled, are the most economical, using less than 2½lb. of coal per horse-power-hour working at 110lb. to 115lb. of steam per square inch. High rotative speed is not necessary for electric lighting, but it does require a steady and uniform speed. An engine running 40 revolutions per minute, provided the speed is regular, will make as good lights as one running 300 revolutions.

It has been practically demonstrated in a great number of plants, which have used the small, high rotative speed engines, that such is the fact, the low speed using less coal, oil, and attention, while the cost for repairs is very much less, as well as loss of steam from radiation, clearances, etc., than high-speed engines. On a pair of Corliss engines 23in. by 48in., at 75 revolutions per minute, running day and night for nearly seven years, the actual cost for repairs was but 25dols., and during that time they were shut down but once on account of breakage, and then only 10 minutes to disconnect one engine, the other being run with the load of both at increased steam pressure.

SHAFTING.

The friction of a high rotative speed engine and a 60-light dynamo is 6 i.h.p., while the friction of one pair of engines, shafting, 22 empty dynamos, 11 idlers, and 22 Hill clutch pulleys, 5ft. in diameter and 12in. face, is but 72 i.h.p., both running up to speed. The only argument against large engines is that in case of breakage it stops the

* Paper read at the National Electric Light Convention at Niagara Falls.

whole plant, whereas, in a series of small engines, connected direct, it will stop but one dynamo.

In all cases shafting should be made of hammered iron, and for a 1,000-light station the main light should be 75ft. long and 6in. in diameter, and about 55ft. of counter shaft, commencing at 5in. diameter and reducing $\frac{1}{4}$ in. for every two machines, to be located on the ground floor, with pedestals as low as possible, and bearings of cast iron, not less than four to one. The main bearings ought to be of phosphor bronze, and the shafting run not less than 300 revolutions per minute. The expense of oil on such a shaft, with proper appliances, will not be over 3dols. per year.

The driven pulleys from the engines should be on the two ends of the main line of the shaft, with a clutch cut off between one engine and the first dynamo pulley, one between the last dynamo and counter pulley, and one between the counter pulley and the other engine, with a clutch on the counter pulley. This will give perfect control of the main shaft and counter shaft, and can either run one or both engines, as the load may require.

DYNAMOS.

The dynamo-room should be directly over the shaft lines, so as to use angle belts. The light should be good, and the ventilation perfect. The roof should be supported without posts and be of sufficient height so that the dynamos or armatures can be hoisted and carried over the ones that are running. Insufficient room overhead is a great drawback to the successful handling of electric light machinery.

The dynamos should be small and mounted on cast-iron beds, left entirely open to allow perfect cleaning, as the life of dynamos depends very much upon their cleanliness. They should be placed in rows, with sufficient space between them to allow easy access to all of their parts, as well as ample room, that they may be moved from one part of the room to another without disturbing those that are running.

If the roof cannot be made sufficiently strong to support the combined weight of dynamo and armature on a track, then a good substitute is a frame supported on large casters, with a track over the top, having on it a chain-gear trolley and a chain hoist. This will allow of the rapid lifting of the dynamo, its moving to some other place, rolling the hoisting frame to that place, and putting the dynamo in proper position for running. With this arrangement, a three-ton machine may be moved and put in running order in 30 minutes, requiring but four men; with a little longer time, two men will do the same work.

A cupola should be provided, not smaller than 10 by 30ft. and 10ft. high, with window ventilators extending the full length of the two sides, and so arranged as to be under the full control of the machine man. With such a cupola, one is enabled to put the lines in good shape, as well as to carry off a large amount of heat. The wires should run to the switchboard from binding posts placed through the centre of the cupola, and all crossing of lines should be made at this point.

SWITCHBOARD.

The switchboard should be placed in the middle of one side of the dynamo-room, and 4ft. from the wall, and should be at least 25ft. long, which will give room for 50 circuits. As it is impossible to keep all circuits built up to the full capacity of the machine, it is well to have a number of small circuits to couple in, in order to build up to the full machine capacity, as all dynamos work more economically with a full load.

The line wires should come into spring jacks, which are arranged in two rows, with one side of the circuit on top and the other below, with 8in. of space between them, so that there is no possible danger of a person being liable to touch or short-circuit two of them. Before attaching to the spring jack, one side of the circuit should pass through an indicator for showing the direction of the current. The wires from the dynamos should be run beneath the floor, coming up on the back of the switchboard, and enter binding posts, to which a flexible cable should be attached, having a wooden-handled plug for entering the spring-jack. *These cables should be of sufficient length to reach either*

end of the switchboard. The spring jacks and binding posts of the machine cable should be so arranged that a connection cable can be hooked on for the purpose of moving the machine cable from one circuit to another, to cut out or cut in circuits, without extinguishing the lights already burning. The positive wire coming from the dynamo should pass through an ammeter before entering its binding posts.

A good arrangement for making ground tests and locating grounds while lights are burning is a set of thirty 92-volt incandescent lamps in series, so arranged with a circular switch that any number may be short-circuited at will. With one side of this lamp circuit connected to ground and the other side connected to the line to be tested, a ground on the line will show by one or more of the lamps burning.

I find that with the lamp burning, on, say, the positive side of the test circuit, with an E.M.F. of 92 volts, the ground may be looked for between the second and third arc lamp on that side of the circuit; in fact, each 92-volt lamp will represent two arc lamps or their equivalent in line wire resistance. This is a simple and handy method of locating grounds, especially if the positive and negative side of the circuit are much separated, for it starts one out on the right end of the wire, which is rarely the case, without some reliable method of testing. When two grounds occur at night, cutting out a number of lights, it is necessary to be able to start out with some knowledge of its locality, especially if such a circuit is from 12 to 15 miles long, and starting out from one point of the compass and returning by another.

If there is an indication that the full number of arc lamps are not burning on a circuit, by attaching one side of this test to the positive and the other to the negative spring jack of the circuit in doubt, it will show within one or two lamps of the number that are burning.

Ammeters, lightning arresters, indicators, and all connections should be placed on the switchboard.

LINES.

Lines in all cases should be supported on glass or porcelain throughout their whole length, and should never enter a building without passing through hard rubber tubing with water-drips on the outside. In all cases inside wires should be run on glass or porcelain insulators; mouldings or cleats should never be used for arc light wires, and in no case should they be put under floors or out of sight.

All arc lamps should be hung on porcelain insulators, and in the case of outside lamps all iron should be galvanised to prevent the rust from collecting on the insulators, which gives a first-class ground, if the fixture connects to tin gutters or ironwork.

All lines should be tested for grounds at least three times during the day, and once every hour while the lights are burning; as soon as a ground occurs it should be immediately found and cleared.

STOREROOM.

The storeroom should be of good size and provided with cupboards, drawers and shelves, that a full line of all supplies can be kept on hand and issued only on requisitions from foreman of construction gang. When a job is completed a return should be made of the material returned and the charge entered in the proper books.

A carbon book should be kept in which each trimmer signs a receipt for the carbons issued each day, as the trimmer reports each day the number of carbons used on his route. The stumps returned must accord with the report at the end of the week; he must account for the number of carbons on hand or pay for them. The trimmer will only pay for one lot of lost or broken carbons, as he finds it easier to take care of carbons than to buy them.

SHOP.

The shop should be of good size and provided with at least one 12in. lathe, drill press and buffing wheel, with sufficient small tools for all kinds of repairing and the manufacturing of switches, fixtures, insulators, and all the thousand-and-one articles that come up for use in such a station.

The test rack should be located in the shop, and be large

enough to hold at least four lamps, each lamp to be provided with an adjustable lens for focusing the arc of a lamp on a screen; this affords a good opportunity of closely watching the arc without injury to the eyes, and has a capacity of from seven to ten lamps per day.

ECONOMICAL SIZE OF LINE WIRE FOR CONSTANT-CURRENT CIRCUITS.*

BY MR. E. RHODES.

The writer has for some time been accustomed to use a formula for finding the economical size of line wire for constant-current circuits, and has been requested to present it at this time. With the knowledge that it is not new, and yet that it is needed by many practical electricians, the following is submitted:

Let X = diameter of line wire in mils.
Let A = length of circuit in miles.
Let B = price of copper per pound.
Let C = cost of power per year per horse-power.
Let E = amperes of current.

When any plant is about to be established, B and E are known, C can be determined near enough for our purpose, and A will be found to be immaterial.

·016 X^2 = pounds of wire per mile.
·016 $B X^2$ = cost per mile of wire.
·0016 $B X^2$ = interest and depreciation at 10 per cent.
·0016 $A B X^2$ = annual cost of wire. (1)

$$\frac{54,577}{X} = \text{ohms per mile.}$$

$$\frac{54,577 E^2}{X^2} = \text{watts per mile.}$$

$$\frac{54,577 E^2}{746 X^2} = \text{horse-power lost in transmission per mile.}$$

$$\frac{54,577 C E^2}{746 X^2} = \text{cost of same.}$$

$$\frac{54,577 A C E^2}{746 X^2} = \text{annual cost of power lost in entire circuit.} \quad (2)$$

It is plain that with any increase in the size of wire the value of (1) will increase, while (2) will diminish, and the economical value of X will be such that the sum of (1) and (2) will be a minimum.

Let u = this sum:

$$u = .0016 A B X^2 + \frac{54,577 A C E^2}{746 X^2}.$$

$$\text{Differentiating, } \frac{d u}{d x} = .0032 B X - \frac{109,154 E^2 C}{746 X^3}.$$

Placing this equal to zero, and reducing, we have

$$X^4 = \frac{45,700 E^2 C}{B}.$$

This formula shows that the diameter of wire depends on the price of copper, cost of power, and quantity of current, and is entirely independent of the length of the circuit and the voltage.

The differential coefficient shows that the formula is in harmony with Sir William Thomson's rule that "the additional running expense due to the resistance of the conductor shall equal the interest on its first cost."

Price of copper refers to the bare wire without any covering or insulation whatever. The insulating cover is a mere matter of choice, like a brick, stone, or frame station.

A few examples are added for illustration, the price of copper assumed at 20 cents per pound for facility of calculation.

What size wire should be used in a transmission of power plant using a 40 ampere current, power costing 100dols. per year per horse-power?

Here $E = 40$, $C = 100$, $B = 20$. Substituting $X = 427$ mils, or nearly No. 0000 wire B. and S. gauge.

If the power costs 50dols. per year then $C = 50$ and $X = 359$, or 00 B. and S. With water power at 10dols. per year, $X = 240$, or between Nos. 2 and 3 B. and S.

* Paper read at the National Electric Light Convention at Niagara Falls.

Should a 20-ampere current be used in the three cases above, the results would be respectively:

$X = 302$, larger than No. 1 B. and S.

$X = 250$, larger than No. 2 B. and S.

$X = 170$, between No. 5 and 6 B. and S.

What size wire is economical in an ordinary city are light 10-ampere circuit, steam power costing 50dols. per year?

$E = 10$, $C = 50$, $B = 20$;
giving $X = 180$ mils or No. 5 B. and S.

Suppose water power can be furnished at Niagara Falls for 10dols. per horse-power per year and a 10-ampere current generated by this power be used for street lighting in Buffalo, the entire length of circuit being 50 miles, what is the economical size of line wire?

A substitution in our formula gives $X = 120$ mils, equal to No. 8 B. and S., or exactly No. 11 Birmingham wire gauge.

THE VESTRY OF CHELSEA.

SEVENTH ANNUAL REPORT OF THE ELECTRIC LIGHTING COMMITTEE, 1888-9.*

Committee—Mr. Moon, chairman; Messrs. Irons, F. Kingsbury, Oakeshott, Osborn (*ex officio*), Stroulger, Thomson, Wheeler, H. Young.

Three seats being vacated—two by the retirement by effluxion of time of Messrs. Davidge and Hilton, and one by the appointment of Mr. Osborn as an *ex officio* instead of an elected member—led to a change in the constitution of the committee by the appointment of Messrs. Irons, F. Kingsbury, and Oakeshott at the first Vestry meeting after the ward elections.

Fifteen meetings of the committee have been held during the year, at the first of which Mr. Charles Mossop, who had been chairman of the committee since its formation, was again unanimously elected chairman. To the regret, however, of the committee, Mr. Mossop, whose services on the committee were most valuable, felt called upon in January to resign his seat on the Vestry, and consequently upon this committee, when Mr. Ernest Moon was elected as chairman.

An agreement which the Vestry, on the recommendation of this committee, entered into with the London Electricity Supply Corporation, whereby they were permitted to lay mains temporarily upon the same terms as the Chelsea Electricity Supply Company upon condition that they applied to Parliament for a provisional order, has given rise to considerable correspondence and attention on the part of the committee. The Chelsea Electricity Supply Company contended that they were entitled to a monopoly within the district defined in their provisional order, confirmed by Act of Parliament, and objected to the laying of mains by the London Electricity Supply Corporation.

The committee received notices from three electric lighting companies that it was their intention to apply for provisional orders to light the parish with electricity, but only one, i.e., the London Electricity Supply Corporation, deposited a draft provisional order. The order having been gone through by the chairman and surveyor, and several alterations having been considered necessary by them, it was left in their hands to arrange matters with the corporation, who agreed to make the alterations which were suggested.

The provisional order applied for by the London Electricity Supply Corporation embraces the whole of Chelsea parish, as well as other districts in the metropolis, and an enquiry is now pending before an official of the Board of Trade for the purpose of enabling the Board of Trade to determine whether it would be politic that such extensive powers should be granted, and whether and to what extent competing companies should be allowed to supply electricity within the same district. The surveyor was authorised by the Vestry to give evidence at this enquiry, with a view to show that the interference with streets¹ if competition was allowed, would not be either so frequent or so extensive as to be inconvenient, and the committee's opinion is that the competition which the London Electricity Supply Corporation has introduced, and asks for powers to maintain, has been and will be beneficial to those who require electricity in this parish. This view has been expressed to the Board of Trade at an interview, which took place in February, between Mr. Moon with the surveyor and clerk and Messrs. Calcraft and Boyle, and has also been made sufficiently apparent to the Board of Trade inspector at the enquiry now pending. The existence, in fact, of the mains of two companies in certain streets in this parish without inconvenience will, the committee believe, go far to show the fallacy of the argument which is being used by several companies, who desire to supply electricity, in favour

* From the Thirty-third Report of the Vestry of the Parish of Chelsea.

of the policy of monopoly that alarming consequences will ensue if more than one company is permitted to supply electricity in the same district.

A memorial, signed by 432 persons, protesting against the erection of overhead electrical conductors, was remitted to the committee in December, when the committee recommended that the petitioners be informed that the jurisdiction of the Vestry is limited in extent, difficult of application, and doubtful in its effects, and that they are not prepared at present to initiate proceedings against the owners of the overhead wires.

The committee had under consideration during the year the Electric Lighting Act, 1882, Amendment Bill, when, after receiving an exhaustive report from their chairman and surveyor thereon, the committee recommended the insertion of a new clause, providing that overhead wires for the supply of electricity might only be laid under the terms of a provisional order or license. This Bill, however, was not proceeded with.

In July the committee were informed that the amount of the capital required by the order of the Chelsea Electricity Supply Company had been subscribed, and that the amount required by clause 9 of the order had been deposited with the Board of Trade. The committee have recommended that certain parts of Schedule B of the order should be added to Schedule A, and are pleased to be able to report that the works of the company have now so far progressed that the deposit required has been released, and that they are now in a position to supply a portion of the parish with electric light.

ERNEST MOON, chairman.

NEW COMPANIES REGISTERED.

Alcoy and Gandia Railway and Harbour Company, Limited. Registered by Ashurst, Morris, Crisp and Co., 6, Old Jewry, E.C., with a capital of £525,000 in £100 shares. Object: to take over, construct, acquire, equip, maintain, and complete works, railways and harbours in the kingdom of Spain or elsewhere, and for such purposes take over, hold, and exercise all or any of the rights, privileges of any authority, concession or concessions for the construction, equipment, and working of the same, and to enter into and carry into effect any contracts, and to maintain and work any other railways, tramways, electric or other power, telegraph and telephone lines and works, or other means of communication or appliances of a similar nature in the kingdom of Spain or elsewhere. The first subscribers are:

	Shares.
A. Mitchell, 15 Davenant-road, N.	1
F. C. C. M. Fighura, 116, Ebury-street, S.W.	1
W. R. Dyett, 8, Berkeley-road, Crouch End, N.	1
H. A. Millar, 40, Rockborne-road, Forest Hill, S.E.	1
H. M. Merriman, 10, St. Andrew's-road, Surbiton.	1
S. F. Kemp, 1, Doughty-street, W.C.	1
F. Bresse, 4, Bernard-street, W.C.	1

There shall not be less than three nor more than five Directors. Qualification, £500. The first to be appointed by the subscribers to the memorandum of association. Remuneration, £1,100, of which £300 shall be allowed to the Chairman, and the balance divided among the other Directors as they may determine.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts of this Company for the past week amounted to £4,465.

Western and Brazilian Telegraph Company, Limited.—The receipts of this Company for the week ended August 23, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,303.

PROVISIONAL PATENTS, 1889.

AUGUST 19.

13047. **Improvements in arc lamps.** John Hall Rider, The Northern Telegraph Works, Square-road, Halifax.
13057. **Apparatus for giving temporary use of telephones in exchange for coin.** Bélizaire Marinovitch and Géza Szarvady, 55 and 56, Chancery-lane, London.

AUGUST 20.

13089. **An improved light field telegraph.** Alexander Glen, 3, Elm-court, Temple, London.
13135. **Improvements in coin-controlled apparatus for use in connection with telephones.** Henry Harris Lake, 45, Southampton-buildings, London. (William Gray and Charles Soby, United States.) (Complete specification.)
13148. **Improvements in alternating current electric motors.** Thomas Parker, John Harold Woodward, and Edmund Scott Gustave Rees, 47, Lincoln's-inn-fields, London.

AUGUST 21.

13154. **Improvements in constructing or winding coils for electrical apparatus.** Thomas Mather and William Edward Sumpner, 5, Melrose-terrace, Lillie-road, Fulham.
13168. **Supporting electric lamps on the surfaces of iron or steel structures by means of a magnet, and preserving from abrasion its conductors.** Albert McCandlish and Sidney Harper Heywood, Central House, Bredbury, near Stockport.
13172. **Improvements in conduits for laying underground electrical conductors, and in the means for supporting, guiding, and insulating the said conductors therein, and in clips for holding together the strips of conductors constructed of thin strips of metal.** Frederik Vilhelm Andersen, 156, Strand, London. (Complete specification.)
13183. **Improvements in apparatus and in the combination thereof for lighting railway carriages, tramcars, and other vehicles by electricity.** James Radeliffe, East Retford, Nottinghamshire.
13191. **An electro-magnetic protector for electrical instruments.** Thomas Alden Dickson Forster, Norristown, Pennsylvania, United States.

AUGUST 22.

13223. **Improvements in electrodes and filaments for electric lamps, and in materials for the same.** Charles William Beesly, 6, Gray's-inn-square, London.
13273. **Improvements in arc lamps.** Charles Julian, 132, Arlington-road, Camden Town.
13292. **Improvements in electric lamps and means for securing electric lamps in carriages and like vehicles.** George Francis Slatter, 166, Fleet-street, London.

AUGUST 23.

13297. **An improved telephone mouthpiece.** Locke Cotterell, Greenhill Cottage, Crossmyloof, Renfrewshire.
13322. **Improvements in the means or apparatus for transmitting electric signals.** Ernest Jules Pierre Mercadier, 55, Chancery-lane, London.
13323. **An improved method of carrying main leads and other electric wires along streets and other thoroughfares.** William Smethurst, 80, Strand, Middlesex.
13336. **Improvements in electric arc lights.** Charles Wells and Joseph Brown, 22, Southampton-buildings, London.

AUGUST 24.

13344. **Electro-therapeutic cap.** William Phillips Thompson, 6, Lord-street, Liverpool. (Theodor Biermann, Germany.)
13371. **Improvements in single needle telegraphs and other electric instruments.** Thomas Hugh Parker and George William Fairall, 77, Colmore-row, Birmingham.
13382. **An improved electric alarm or water level indicator, chiefly applicable to the water-gauges of steam-boilers.** Mathias Beckers, 433, Strand, London. (Complete specification.)

SPECIFICATIONS PUBLISHED

1888.

1386. **Telegraph insulators, &c.** Fowler. (Amended specification). (Complete specification). 8d.
11328. **Obtaining electricity.** Boggett. 6d.
11963. **Electric rail or tramway systems.** Smith. 8d.
13078. **Electric resistance meter and rheostat.** Guerin. 8d.
13965. **Traveller for overhead telegraph wires, &c.** Atkins. 8d.
18278. **Laying electrical conductors underground.** Wilkinson and Holmes. 8d.

1889.

6078. **Electric arc lamps.** Gobert. 6d.
9153. **Dry galvanic battery.** Arnold and Coryell. 6d.
10295. **Electric telegraphic apparatus.** Thompson (Burke). 8d.
10708. **Automatic electric cut-out.** Currie. 8d.
10709. **Insulators for electric batteries.** Currie. 6d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.	Name	Paid.	Price Wednes- day
12 Feb. 1/2	Anglo-American Brush E.L.	—	—
12 Feb. 2/0	— fully paid ..	—	—
14 Nov. 0/4½	Con Telephone & Main ...	1	3
27 July 10/0	India Rubber, G. P. & Tel.	10	19½
.....	House-to-House	4½	4½
.....	Metroptn Electric Supply	—	2½
.....	London Electric Supply ...	5	3½
.....	Swan United	3½	4½
12 July ... 12/0	Telegraph Construction ...	12	43½
2 July 6/0	— 6%, 1889	100	105
... ..	National Telephone	5	6½

NOTES.

Sheffield.—The central station at Sheffield is to receive another Mordey alternator.

Genes.—The town of Gênes has been lighted up by M. Prène, electrical engineer of that town.

Storage Cars in Washington.—The trial is to be made of Julien electric cars at Washington.

Flensburg.—A central station, to be constructed by Messrs. Schopke, of Berlin, is being erected at Flensburg, Schleswig.

Amalgamation.—The American Thomson-Houston Company and the Forte Wayne Jenney Company have amalgamated.

Schmidt-Douglas Company.—The Schmidt-Douglas Electric Company, of Hustlergate, Bradford, have gone into liquidation.

Melun.—The Municipality of Melun, Seine-et-Marne, is entering into negotiations for the installation of a central station for public and private lighting.

Where was the Conductor?—Messrs. Evans's silk printing mills, at Crayford, were set on fire on Tuesday by lightning, and over £10,000 damage done.

Progress.—The Spanish papers are at the present moment busily occupied in booming electric clocks, of which, it appears, a number have been installed at Bilbao.

Curative Electricity.—An international congress, to consider the application of magnetism and electricity to the alleviation or cure of disease, is to be held in Paris on October 21 to 27.

One-third the Cost.—A Pittsburgh company has undertaken to light the streets of that town with incandescent lights, supplied by underground wires, at one-third the cost of gas.

Bournemouth.—The station at Bournemouth, for which the Brush Company has supplied the plant, is now practically ready. Further engines and dynamos to extend the capacity of this station are being sent off.

Electric Engine at Southend.—Mr. Hemmann has given notice to the Southend Local Board of a motion for the next meeting that he would bring up the question of providing accommodation for an electric engine on the new pier.

Paris Stations.—Following the superb example of the Gare Saint-Lazare, the Compagnie du Chemin de Fer de l'Est are now constructing a central electric light station in the Faubourg Saint-Martin for the purpose of lighting their terminus and waiting-rooms.

Auction Sales.—As our readers will see from advertisements appearing this week, Messrs. Wheatley Kirk and Co., have two sales, important to electrical engineers, of engineers' material and electric plant, which those interested will do well to remember.

Electric Light at Spanish Theatres.—The Teatro de Novedades, in Barcelona, has received a very interesting installation of electric light for scenic purposes. Lightning is also imitated by the electric light, and the sound of thunder is produced by the means of electromagnets.

Electric Light at Puente Genil.—A central electric lighting installation was opened at Puente Genil, Spain,

on the 15th ult. The inauguration was honoured by the presence of the Governor of the province, and a number of the Government officials. The result of the trial was immensely satisfactory.

Dublin.—At an important meeting of the Corporation of Dublin, more fully reported elsewhere, it was resolved, by a practically unanimous vote, to undertake the electric lighting of the city by the Corporation, to the extent, at first, of 10,000 lights, and for this purpose to borrow £50,000 for establishing a central station.

Clock Regulation in Berlin.—A company is to be formed in Berlin, with a capital of a million marks, for the establishment of a system of regulating clocks for private houses by means of the telephone wires, by an automatic "minute-transmitter." The Post Office authorities in Berlin have already agreed to arrangements for the use of the telephone wires.

Carbon Brushes.—Many of the American dynamos and motors are now being fitted with brushes made of a thick plate of ordinary carbon. Some of our electrical engineers had better try this method, and send us their reports upon the subject. It seems to be highly successful in cases already tried, especially for motors, if we may judge from the reports.

Telegraphing to Trains in Motion.—A company is about being formed in Baltimore to place in operation the system of telegraphing to and from moving railway trains, invented by Baylus Cade, of Raleigh, North Carolina. Mr. Cade places a wire along the railroad, near the track, and the communication is made with the moving train by a descending drag.

Electricity on the St. Lawrence.—Use is made of the electric light for steering at night among the thousand isles on the St. Lawrence river. The steamer "St. Lawrence" has a large arc light fitted on the yard arm, supplied by current from the dynamo which was already in use for lighting the saloons, and steers its way with great ease by the guidance of its projector.

Electric Blasting.—An electric battery for firing shots to loosen up hard ore has been introduced at Dahlenega, says the *New York Electrical Review*. The machine is about 9 by 18 in., and it is capable of firing 16 shots simultaneously, which is a wonderful improvement, to say the least of it, compared with the old process of one and two shots, and having to wait several minutes.

Gulcher Station in New Zealand.—The central station conducted by the Gulcher Company at Wellington, New Zealand, is now completed, and a certificate to that effect has been sent to the authorities. It is mentioned, however, that the water-main for supplying the turbine is now large enough to drive the dynamo at its proper speed, and it is expected that a further concession will be asked.

Westinghouse Done Brown.—In referring to the evident antipathy of Harold P. Brown to all things Westinghouse, an American daily very wittily suggests that it would, perhaps, be as well to test the condemned man's strength or "resistance" by a Westinghouse brake. By the way, a new name has been suggested for execution by electricity. This is "Browned"; it has the advantage of being doubly expressive.

Reading.—The electric light station in Reading is now supplying more lamps than the plant was originally

intended to supply, and owing to the increased demand for the light by business firms, the contractors, Messrs. Laing, Wharton, and Down, have arranged for a considerable enlargement of their plant. The street lighting is not yet adopted, the Council having as yet taken no steps to carry out their resolution of June last.

Electric War.—The French Minister of War is making some experiments in electric shooting, and intends to arrange so that he can discharge his guns upon the enemy from unexpected places, by means of an electric current. By placing a battery on a hill, in a fort, or at the entrance to a defile, it would be possible to shoot from a distance or automatically discharge the artillery at any precise point of the line of defence.

Gas Fails.—Electrical engineers should descend in force upon Buxton and Hexham. The people at these places must be in a mood to consider their proposals. Last week the whole of the gas supply failed at Buxton for some minutes, and the lights in the hotels, hydropathics and the pavilion went out, causing the greatest excitement. Hexham has also been in darkness for several days owing to some trouble with the gas lighting in the streets.

Series Incandescent Lighting.—Mr. A. A. Goldston, of Middlesbrough, who has made a speciality of this class of lighting, sends us notice that he is now undertaking long-distance incandescent lighting—either incandescents only or on arc circuits—and with single lamps or otherwise, fitted with his automatic cut-out switches and dynamo regulator, and has now taken a London office at 2, Marlborough-mansions, Victoria-street, Westminster.

Three-Wire System at Kensington.—It is understood that the Kensington and Knightsbridge Company (Crompton's system) are making arrangements to change at an early date to the three-wire system of distribution. The ordinary parallel system has hitherto been used, but as the output extends it is felt well to do more work with the same copper by the adoption of the three wires, and this change will probably be made general in the district.

Telegraphic Communication with the Far East.—According to a Shanghai telegram the Viceroy Li Sheng, Paotai, has nearly completed the preparations for the construction of a telegraph line from Pau Ting Foo, near Peking, through Shansi, to connect with the Russian telegraphic system at the frontier town of Kiachta, in Siberia. When carried out, this new means of communication cannot fail appreciably to reduce the cost of telegrams between China and Europe.

Norwich not Anxious.—At the meeting of the Norwich Town Council, the town clerk reported the receipt of a letter from Mr. Sydney Morse, of 4, Fenchurch-avenue, London, of the intention of the promoters of a company to apply to the Board of Trade for a provisional order to supply electricity within the district, and also a similar notice from the Electric Construction and Maintenance Company to the same effect. He had been asked to acknowledge the receipt of the communications, which he had declined to do.

Electric Treatment of Sewage.—The authorities in Paris have under their consideration the construction of a large sewer with outlet at Achères. This pipe would, it is found, have twice to cross the Seine, and the work would cost several millions, without including the disposal of the soil and the general maintenance. It has been proposed to

consider the application of electricity for this purpose, in order to avoid this immense expense, and, in fact, to do away with the necessity of the undertaking by the establishment of an electric sewage works.

Inspector of Electric Lighting.—Official openings for electrical engineers, so much expected by the ardent students of Finsbury and elsewhere, are now beginning to turn up. The first municipal inspector of electric lighting has been appointed for the Liverpool Corporation. In response to a tentative offer of £150 per annum, the Corporation received 47 applications. This number was reduced to five by a committee, and on Tuesday Mr. E. H. Yeatman, at present assistant electrician to the Ward Electrical Car Company, Limited, London, was elected.

Wolverhampton.—The meeting of the Wolverhampton Gas Company was exercised upon the question of electric light, arrangements having been made since their last meeting to introduce this rival on a practical scale. Expression was given to the feeling that there was no doubt that it would take some of their customers, but it would not do for them to stand still, and by making gas cheaper and other ways they must compete with it. They will no doubt wish before long they had made arrangements to have some of the profit out of the newer illuminant themselves.

Tree Insulation.—Mr. W. M. Davis, electrician of the Plymouth (Mass.) Electric Light Co., has devised a new tie for securing wires to insulators where they run through trees. If tied in the ordinary way the swaying of the trees is liable to break the line wire. Mr. Davis's device is made of wire, leaving an opening through which the line wire is introduced. A sheet metal clip is then inserted, the ends bent down and the wire is secured against the possibility of falling, while it can render freely lengthwise. He has secured letters patent on his invention, which, says the *New York Review*, seems to be a valuable one.

Utilising Water Power.—Another device for the use of water power is announced. This time it is for utilising running streams, and is the novel idea of M. Tuyn, a Russian engineer. His apparatus consists of an endless cable, carrying a series of canvas cones, which open and shut like an umbrella. The cable passes over a double drum on board a pontoon, and at the other end over a pulley suspended from a buoy. On the lower part of the rope the cones are opened and forced forward by the current of water, thus setting in motion a shaft or drum.

Penrhyn.—At the recent quarterly meeting of the Penrhyn Town Council, Mr. James referred to the letter from the secretary of the Falmouth Gas Company, presented at the last meeting, relative to their intended application to supply electricity within the area of Penrhyn. He understood that there was sufficient water at the head of the town which could be stored for the purpose of lighting the borough with electricity, and he considered some steps should be taken by the Council to secure to themselves the right, if desirable, to light their own borough. The deputy town clerk stated that he would look into the subject and report thereon at the next meeting.

Brush Tramway Work.—The electric tramway, which has been under process of construction by the Brush Company, is now practically completed. Mr. Raworth, the company's engineer, who has been for some time in Spain on this business, has now, we believe, returned, or is on his way. Other continental electric

traction enterprises are under way, and the outlook seems very good. The large works at Loughborough, taken from the Falcon Car Company, are being vigorously extended and adapted to the manufacture of electric traction apparatus. These works will be practically doubled, and heavy dynamos and motors will also be made at these works.

The Weems Electric Express.—The high-speed electric railway system of Mr. D. G. Weems, which was recently tried at Laurel, near Baltimore, has, it appears, so far satisfied the inventor, and his friends have determined to build a longer experimental track of five miles to demonstrate the possibility of passenger traffic. The speed allowed on the two-mile track was two miles a minute for ten minutes with a three-ton motor, which would be equal to three miles a minute on the straight track. The new line is to be built on Long Island, and will be used to demonstrate both passenger traffic besides the automatic transmission of letter packages and light despatches already tried.

A Gigantic Lighthouse.—The largest lighthouse in the world has recently been erected at Hantsholm, on the coast of Jutland. The tower contains two steam-engines, each of 35 h.p., for driving the two Meritens dynamos that supply the electric current for the gigantic lamp at the summit of the lighthouse. The lamp, which is constructed on Le Baron's principal, shows a constant light of 2,000,000 candle-power, and is so arranged that the keeper can watch and control its working from his room on the ground floor by means of a system of prisms and mirrors, and needs only to ascend to the lantern in the event of damage or to renew the carbons. Besides the lantern the tower contains powerful air-pumps which actuate two powerful fog-signals.

Switzerland.—Brunnen, a small village on the Lake of Lucerne, is now lighted by the electric light. Power for this purpose, says a Swiss correspondent of *Industries*, is supplied by the spinning-mill of Herr Ibach, where water representing 200 h.p. over and above the requirements of the mill is available. The surplus water has been utilised in a small central station, from which Brunnen is supplied with electricity. The station of Bellizona, on the Gothard Railway, has for some years been electrically lighted, and the electric light plant there is about to be extended, with a view to introduce the light throughout the town. A similar extension is proposed for Einsiedeln, where one of the principal hotels has been electrically lighted for some time. In this case a new central station of about 500 h.p. capacity will be required.

Electric Cabs.—Cabby will soon have his nose put out of joint by the application of electricity to his own particular pursuit. Rumours of electric cabs—more or less potential is in the future—have floated about from time to time. We have had a ride on an electric omnibus, and believe an electric provision cart has been already made. But now Sir Edward Watkin has actually been seen last week driving up to the House of Commons in a veritable electric cab, of which he seemed as proud as of a ten per cent. dividend. Things certainly appear ominous for cabby, who will have to turn electrical engineer, or "motorner," as the Yankees say, to earn his living. Sir Edward is always well in the advance of science, and possibly we shall be having a fleet of electric cabs careering the streets before one knows where we are.

Electricity and Swallows.—In the south of France for some time ingenious bird catchers have applied them-

selves to science to obtain their prey, and have erected bare wires connected to high-tension apparatus. The swallows alighting on these wires have been killed by the shock in great numbers. This action is greatly deplored by the French scientific press, and its prohibition is urged both on account of the inhumanity of the proceeding, the usefulness of the birds as destroyers of insects; and, lastly, from the fact that experiments have been instituted at Rouboix to investigate the aptitude for swallows to carry despatches in time of war, and that in this case a "swallow station" should be erected at Mount Valerian and the birds taken under Government protection.

Duty on Electricity.—An amusing question is being raised with reference to the supply of electricity to the States from the Canadian side of Niagara Falls. Is electricity a dutiable commodity? This is the point which exercises the engineers who hope for a large support on American soil. The Treasury has been asked its opinion, but has replied it is contrary to their practice to answer hypothetical questions of this kind. The solicitors to the company think it would be necessary to enact a special Act, but believes the Government are quite capable of doing this and taxing electricity. "It will be interesting," says a local paper, discussing this point, "to see a Customs House officer trying to seize upon an electric current of say 5,000 volts, which was trying to sneak into this free nation without putting up its cash for the privilege."

Electric Railway Switches.—The operating of the switches for railway lines by electricity has been a favourite idea of some electrical engineers, and we note that endeavours are now strongly being made to introduce them in America. Mr. E. L. Condon, of Malden, Mass., has perfected an interlocking system of this description which has received attention from railroad officials. Large storage batteries are placed in a tower at each end of the switching-yard and electromagnets are placed at every switch. The switches are controlled by means of a keyboard in the tower. The pressing down on the key produces an instantaneous switching of the rails, the switch returning to its place when the pressure is removed from the key. By this system one signalman can work a dozen switches at once. An automatic record is kept of each train switched.

Electric Carriages.—The *Progressive Age* gives an account of a wonderful land and marine carriage, invented by a lady, Mrs. Angie Truax, formerly known to the stage as Madam Schott. It is reported as a two-seated car, with heavy bicycle wheels geared to a motor, and also buoyed up underneath with air vessels for crossing streams. It is fitted with paddles behind. The motor has a "vibrating" armature, whatever this may be, and more power is to be obtained from it than from a rotary motor. The battery is an 8-volt dry cell primary, going for three hours. It has electric lights and an electric stove, together with a tent for camping out. A speed of 15 miles an hour is now obtainable, and the lady inventor is confident of increasing it to 30, and is going to apply it also to aerial navigation. Sounds as if Mrs. True—what's-her-name—had been reading "The Amber City."

Bradford Corporation Station.—The arrangements for the supply of electric light in Bradford are now practically complete, and it would be possible, were it considered necessary, to lay on the current at once. The engines have been thoroughly tested, and proved to be up to their work, and all the apparatus, with the exception of some internal fittings at the generating station in Bolton-

road, are in a satisfactory condition. The demand for the new light is not likely to be very great until the evenings lengthen, and as several of the members of the committee are absent, it has been thought advisable to postpone the inauguration of the installation, which will take place, it is expected, some time during the present month. A staff of permanent employes will have shortly to be engaged, and the Corporation are, no doubt, by this time in the position of being able to deal with applications.

Paris Municipal Station and Laboratory.—The Paris Municipal Council, at their last meeting, gave authority for the purchase of measuring and registering instruments, storage batteries, and other necessary apparatus for the municipal electrical testing laboratory. The expenditure is limited to 6,700f. The Prefect of the Seine was also authorised to accept the following contracts for the supply of plant to the municipal station: MM. Henrion, Bardion, Cance, and Rau for arc lamps; MM. Beau, Oudry, Clémence, and Capce for wires, the expenditure not to exceed 65,000f.; MM. Belleville and Co., Lecouteux et Garnier, and the Compagnie Edison for safety apparatus, steampipes, and low-tension switchboards, not to exceed 15,500f.; and M. Patin for transformers (Ferranti system) of a total power of 226,000 watts, for the sum of 30,700f. It is hoped that the municipal station at the Halles Centrales will be ready to work in October.

Telephone in Paris.—Great excitement has taken place in electrical circles, or at least in telephone circles, this week in Paris, by reason of the transfer or confiscation of the telephone rights. In July a Bill was passed cancelling the concession to the Telephone Company and placing the telephonic communication in the hands of the Post Office as a perpetual monopoly. The company naturally strongly objected, protesting that their concession, which was for 15 years, should be kept to, and that the Act was one of arbitrary confiscation. On Tuesday last the Act came into force. Twelve engineers were appointed to take possession of the district telephone offices, and each engineer went to his indicated place accompanied by a police officer. The telephone company were expecting the visit, and had marshalled all their clerks as usual, and had instructed a process-server to be in each office to serve a protest on the engineer, alleging that the offices were private property and held on leases from private persons. The head of each office also formally made his protest, but had to allow the engineer to take possession in the name of the Government. The matter will probably come before the courts.

Electrical Execution Doomed.—The recent semi-official trial of Harold P. Brown and his system, with the facts and opinions elicited, has resulted in the wholesale condemnation by the press of the use of electricity as executioner. We are not so much ourselves interested in the question—which is not within the sphere of practical politics in England—except, generally, as electrical engineers, but we are glad to find the papers using their proper sense in this matter. A recent article by the *New York Sun* says: "The sentiment against capital punishment seems to be growing, and the expressions which the condemnation of Kemmler to death by electricity have brought out, go to confirm that opinion. The profession of electricians are outraged that the agency which they use should be employed for a purpose so horrible. Adjusting the helmet, binding the head with indiarubber, preparing the chemical

solution, making the electrical connection, testing the resistance, and attending to all the other and many details of the deadly experiment must consume much time; and meanwhile the subject is not likely to remain quiet. It will be a horrible scene. It cannot fail to be so. We doubt if even a professional hangman would care to figure in it, so cold-blooded will the whole business be in that awful and secret place."

Nitrates and Electricity.—Avery Hill, Colonel North's new Italian palace, which is rising on the slopes of Chiselhurst, is to be a modern wonder among dwelling-houses, in which electricity is to play a large and carefully planned part. The picture gallery is 100ft. long by 50ft. broad. At one end is a lofty vestibule to be filled with sculpture, and at the other a marble musicians' gallery, supported by columns of Mexican onyx. The dining-hall (outside which runs a vaulted verandah 50ft. long) will be panelled with finely carved Spanish mahogany; a broad corridor, paved with Pompeian mosaic, runs through the house; and the billiard-room is to be decorated from floor to ceiling with slabs of "Numidian yellow," "pink Pavonazzo," and Verdi Antique. A garden-court which lights the library is lined with old-gold colour faience, and the best looms in France are busily engaged in producing the thousands of yards of crimson silk velvet required for the adornment of the ballroom. A winter garden, exactly one hundred feet square, leads to a fernery almost half as large; three lofty towers are now almost finished; and the entrance porch is built of Portland stone, relieved by panels of carved and gauged brickwork. Mr. W. H. Massey, the Prince of Wales's electrician, is to superintend the lighting of the interior. The Nitrate King has been promised that he shall take possession of his new dominions before the end of November.

Portelectric System.—An express electric system of transmission of light matter for postal or parcel service, introduced under the name of the Portelectric system, is being tried on a practical scale in the States. This system, distinct from the Weems, has no motor, but a series of large solenoid coils, mounted at short intervals along the line, and through these train is magnetically sucked along. The New England Portelectric Company have on exhibition a one-third size model of their invention. Several thousand people have witnessed the working of the model, and the project has so gained the confidence of the public that enough stock has been purchased to warrant the directors in building a line in the vicinity of Boston. Mr. J. T. Williams, the inventor, and Prof. Dolbear, the electrician, together with the directors, have selected a site in Dorchester for the location of this line. The track is to be one mile in length and elliptical in form. The location selected embraces all conditions of grades and curves likely to be encountered in running a line for practical use. The success of this experimental road will, no doubt, ensure the success of the Portelectric on a larger and more practical scale. A competent civil engineer of this city has the contract for building the road, and it is to be completed before October 1. The company will generate its own power, and a public exhibition of the line on a practical scale is promised at an early date.

Belfast.—At the monthly meeting of the Belfast Corporation, the report of the Gas Committee was brought forward, and in an appendix to the report it was stated that the committee are of opinion that the time has arrived when the Council should obtain powers to supply electric

light within the city, and they accordingly recommend that they be authorised to apply to the Board of Trade for a provisional order. Mr. Allworthy said there was no doubt that there was a growing desire for it in public buildings and large warehouses and factories. Therefore, he thought the Corporation would be entirely behind the times if they did not recognise that fact in connection with what gave promise of being in all probability the great lighting power of the future. If the Corporation did not take the matter up there were companies who would, and he thought that as the Gas Committee had hitherto managed the lighting of the town with such excellent results, it would be a pity and a mistake to allow it to pass out of their hands. He thought the committee were right, therefore, in seeking to get the powers in question. It would be seen that it was not necessary to get an Act of Parliament for the purpose. The Board of Trade could confer the powers required, and would do so, he was sure, if they were applied for. The Mayor said it was evidently undesirable that any other company should anticipate the action of the Corporation, and he was of opinion the two should have parallel action. The report was adopted. The Corporation will therefore apply for powers.

Provisional Order for Bacup.—At the monthly meeting of the Bacup Town Council, a letter was read from the Bacup Tradesmen's Association, stating that a resolution had been passed by the association to the effect that the Town Council be asked to promote a Bill in Parliament for power to supply electricity in the borough, and to oppose any such applications that may be made by companies outside the town. At the meeting of the General Works Committee, held on the 19th August, the following recommendation to the Council was formed, and the recommendation was now adopted by the Council: That the Council instruct the town clerk to give notice to the Lancashire and Cheshire House-to-House Electricity Company, Limited, of 3, Cook-street, Liverpool, and to the Municipal Electric Light and Power Corporation, Limited, of 33, Old Broad-street, in the City of London, who have given notice to the Corporation of their intention to make application to the Board of Trade for provisional orders, to be confirmed by Parliament in the session of 1890, to authorise them to supply electricity for public and private purposes within the borough of Bacup, that in the event of such proposed applications being made, the Corporation of Bacup will strenuously oppose the same, and also inform the said companies that it is the intention of the Bacup Corporation themselves to make a similar application for the borough. The town clerk also wrote to the Rawtenstall Local Board to say that in all probability the Corporation would also apply for a provisional order within that borough, but in any circumstances they would watch the applications.

Lightning and the Eiffel Tower.—It may be remembered that it was mentioned a week or two ago that the Eiffel Tower had been struck by lightning. *Electricité* seems to think that it is more than doubtful if the tower has been struck at all in the usual sense of the term, though it has acted as a conductor to earth. The tower has had several bad days, during which the lightning struck, more than once, the plain of Grenelle and especially the hills of Passey: but objects embraced in the zone of protection of the tower, taken in its largest sense, have never been struck. Once only, certain persons pretend that the summit of the

tower has been touched. But the fact is contested by the experimental observers who were in the interior of the Exhibition, and were able to count the interval of time between the flash and the commencement of the thunder. None of the thousands of visitors who crowded the different platforms of the tower noticed the least electric shock. The only effect upon the instruments of M.M. Richard frères, who have a stand connected by wire with the observatory, was the stoppage of a clock which took place somewhere about this time. It has been proposed both to put up a continuous lightning-conductor, and also, by one well-known physicist, to clear the tower of visitors every time a storm approaches. The engineers of the tower, however, have quite sufficient confidence in its own conducting power, and have adopted no special means of protection. On the other hand, the *Bulletin International* state that M. Foussat, chief of the electric service, saw several drops of molten copper fall, as he thinks, from the conductor, which was more for ornament and to reassure visitors than any other utility. The guardian of the lighthouse, who was at the opening which gives access to the flag, says he was enveloped for some minutes in a white opaque cloud like a mass of snow, which reflected the light of the arc lamp sufficient for him to read by. A meeting of the engineers will be held to consider the various statements.

Domestic Lighting for Chelmsford.—On Monday evening several gentlemen, who were joined for a short time by Mr. Alderman Duffield, chairman of the directors of the Chelmsford Gas Company, inspected an installation of electric light at the residence of Mr. Fell Christy, Broomfield-road, Chelmsford. Mr. Frank Christy, son of Mr. Fell Christy, was one of the first of Mr. R. E. Crompton's pupils, when the Arc Works were established at Chelmsford. About five years ago he started business for himself in conjunction with his father and Mr. Norris, under the title of Messrs. Christy, Son, and Norris, and he has since taken an active part in developing the electric light—laying down from forty to fifty sets of plant in various parts of the country. The orders, for the most part, have come from a considerable distance—the majority from the Midlands, a demand for the new illuminant not yet having arisen in the eastern counties. A few months ago, however, the firm lighted Messrs. Marriage's mills at Colchester; they have also put down plant at Cambridge, and they are now contemplating extensive operations at Chelmsford. Messrs. Crompton and Co., Limited, who are preparing to light the streets of Chelmsford by electricity, will take out a license from the Board of Trade for the purpose, but they have arranged with Messrs. Christy, Son, and Norris, who have made interior lighting a speciality, to introduce the electric light to shops and private houses where required. Messrs. Crompton will, however, supply the current and a great part of the material. As an example, therefore, of what can be done, Mr. Frank Christy has fitted up his electrical factory and home with incandescent lamps, and on Monday he invited a party of gentlemen to inspect the installation. The drawing-room, study, and bedrooms, fitted with incandescent lamps of various powers from 8 to 32 c.p., were shown, with various useful and artistic fittings, and the convenient arrangement of the switches behind doors or near the bedhead was also much admired. The company left much impressed with the advantages of the light now to be introduced in the town. Mr. Christy mentioned that some score or so business men in Chelmsford had already entrusted him with orders.

THE ELECTRICAL CONGRESS AT PARIS.

(BY OUR SPECIAL CORRESPONDENT.)

The great electrical event of the Paris Exposition has come and gone. During the whole of last week, those of us who were fortunate enough to get away from business and visit the great world's fair in Paris were busily engaged in congress work; or, at least, we made believe to be so engaged, for, after all, there was more pleasure and sight seeing than real hard work; and as for the Institution of Electrical Engineers, who had after many and long deliberations of their council, resolved to hold a special meeting in Paris, the council, secretary and general body of members seemed quite satisfied to drop their independence and allow themselves to be taken in tow by their French confrères. This frame of mind seemed the more justifiable as their French hosts were really doing all they possibly could to make the stay of the members of the Institution pleasant. In this they succeeded admirably, and as we have been treated with so much hospitality it would be hardly fair to dwell too much on the scientific shortcomings of the congress. The situation is best summed up in the statement that we did not expect any very remarkable result from the Paris congress, and that practical experience has justified our negative expectations. In its modest way, however, the congress has done some useful work, and we propose in the following to give a short account of its proceedings.

There was, as a kind of inauguration, first a joint meeting of the Institution of Electrical Engineers and the International Society of Electricians on the evening of Friday, the 23rd ult. M. Mascart delivered an address of welcome, to which Sir William Thomson replied, and then we had discourses by several French scientists, and exhibitions of the telephone, telephone phonograph, and of a very interesting apparatus for the manufacture of artificial or vegetable silk. This apparatus reproduces faithfully the *modus operandi* of the silkworm, the raw material used being a kind of semi-liquid cellulose, and as regards mechanical strength the finished product leaves nothing to be desired. There were also shown woven fabrics made from threads of artificial silk, but they lacked the peculiar softness of the real article, and those of us who had hoped to find in the new preparation a cheap and efficient substitute of real silk for insulating purposes were disappointed, because the artificial silk is a highly inflammable and almost explosive substance. The first meeting of the congress took place on the following day, and was exclusively devoted to the preliminary business of organising the four sections between which the work was to be divided. The first section was to deal with units of measurements, and with other questions of a purely scientific nature, the second with the industrial applications of electricity, the third with telegraphy and telephony, and the fourth with electrophysiology.

The real business of the congress began, however, only on the Monday, and the proceedings in the second section were naturally the most important to the general body of electrical engineers. At the outset, however, it became apparent that the programme had to a certain extent been left to chance, or, to speak more correctly, that there was no definite programme at all. Whoever had paid his 20 francs was a member and might read a paper if he cared to do so. Most members did not care to do so, and on the first day it looked almost as if we should have too few papers to occupy the allotted time of our sittings. On this day we had only two papers, one by M. Crova on the photometry of electric lamps and the other by M. Bède on an electric light installation, in which he had used the exhaust from the engine for heating the building. On the following days we had, amongst other papers of minor importance, some which deserve special mention. These were: one by Prof. Silvanus Thompson on motor generators, one by General Webber on the Chelsea central station, one by Mr. Crompton on secondary batteries for central stations, one by M. Faure on secondary batteries, and several papers on dynamos, transformers, batteries, alternate-current motors,

town mains, concentric *versus* single cables for alternating currents, and similar subjects. To us and our English colleagues, who were accustomed to the lively and exhaustive discussions taking place at the Institution, the listless and superficial way in which these various papers were discussed by the members of the congress seemed rather inadequate, but the want of interest was probably due to a growing feeling that the reading and discussion of papers, which were, for the most part, hastily prepared and of secondary interest, was, after all, not the legitimate work of an international congress. It was only when on Friday, the last day of the sectional meeting, M. Hospitalier pointed out the desirability of agreeing on certain terms to be used in alternating-current work, that the congress entered upon its proper function, and that only after a strong appeal from two of its English members. A special afternoon meeting was then held, and we settled down to earnest work. At that meeting we settled that the unit of induction shall be the quadrant and not the secohm,

that the term $\sqrt{R^2 + \left(\frac{2\pi L}{\tau}\right)^2}$ shall be called the *Appa-*

rent Resistance, that the *Mean Current* from an alternator shall be computed on the basis of the weight of silver it could throw down if commutated and passed through a bath, and that *Effective Current* should be the term employed to designate that value of the current which produces heat effects, and which is measured by a Siemens dynamometer. The effective current is, therefore, given by the square root of the mean square of current, and similarly the *Effective E.M.F.* is given by the square root of the mean square of E.M.F. as measured by a voltmeter. It was also settled that the time during which an alternating current passes through a complete cycle shall be called the *Period* of the current, and that the number of periods per second shall be called *Frequency*.

On a previous day a proposal had been made to agree upon the names of the two sets of plates in a secondary battery, and though a somewhat animated discussion had then taken place, in which a variety of names were suggested, the congress had failed to come to an understanding. Now, however, we were in full swing and fit to settle even the most difficult question of nomenclature. The battery question gave us, therefore, but little trouble, and we boldly resolved that we should call that plate positive which had up to the present always been considered to be the positive plate by all practical men, although some of our professors had told us that we were quite wrong and should call it the negative plate. This controversy, therefore, is now settled for ever, and we shall call that plate positive which during charge is connected with the positive pole of the dynamo, and which is the positive pole of the cell during discharge. These various resolutions were unanimously adopted by the general meeting of the congress on the following day, when also the following resolutions, emanating from the first and third sections were adopted. The *Joule* is the unit of work. The *Watt* is the unit of activity, and is equal to one joule per second. The *Lux* is the unit of light, and is equal to the twentieth part of the standard established by the conference of 1884. It is very sensibly equal to the English standard candle. The output of electrical machines is in future to be specified in kilowatts and not in horsepower. All telephone lines in towns are to be worked with a metallic return.

At the general meeting at which this string of resolutions were adopted without even a solitary dissentient vote, and with truly electrical speed, M. Mascart delivered an address dealing with the work done by the congress, and with the great advances made in electrical engineering since the last congress was held. Sir William Thomson followed with a vote of thanks to M. Mascart, to whom he attributed the success of the present congress, and having briefly replied, M. Mascart declared the congress as closed. As a matter of fact, our duties, or, to speak quite correctly, our pleasures were not yet terminated, for in the evening all of us foreign electricians were entertained at a great banquet by our French colleagues, and thus terminated in a fitting manner one of the most pleasant weeks which most of us have ever spent in Paris.

AN AUTOMATIC ELECTRIC READING LAMP.

to ride for a few hundred miles in a railway carriage the light is so dim that it is impossible to recognise a finger upon the opposite seat is somewhat dull. An attempt to read under such circumstances is madness; the use of a flickering candle is very unsatisfactory, and the spots of grease from the same irregularly distributed upon one's best "unmentionables" is calculated to stir up the humor. It was with the object of improving this state of things that Messrs. Davies and Tourtel conceived the idea of an electric reading lamp which should be operated upon self-feeding distributing principles. The apparatus now in operation in some of the carriages of the South-Eastern Railway is not the outcome of a spontaneous idea, but is the result of much careful experiment and thoughtful work.

At present constructed, the apparatus is contained in a box measuring about 6 in. high by 4 in. in width, and the

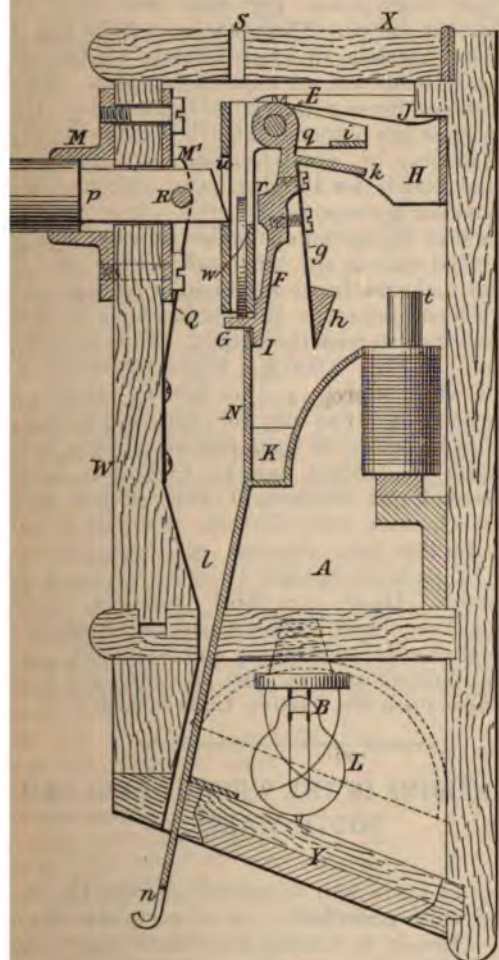


FIG. 1.

box is 6 in. in depth. This is fixed under the hatrail, so that the lamp, which is placed in the lower half of the box (of which the bottom is of glass), shines directly over the shoulder of a person beneath. The lamps at present employed are of 10 c.p. each, and the apparatus is so constructed that the insertion of a penny and the subsequent pressure of a button causes one to remain incandescent for a period of half an hour. The lamp may be extinguished before the expiration of the half-hour by pressing a small button provided for the purpose. We believe this to be the only self-acting automatic machine in existence, for if, from any cause whatever, a light cannot be obtained, the coin falls through the box into a receptacle beneath. An accumulator is provided under the seat of one of the compartments supplies current to all the lamps in one carriage. The English and Foreign rights of this invention have been acquired by the Railway Automatic Electric Light Syndicate, Limited. It is estimated that the receipt of a penny per lamp per day will enable a substantial dividend to be paid on the invested capital. Messrs. J. E. Spagnoletti and Crookes are the English manufacturers.

The following working details have been supplied to us by the inventors: In Fig. 1 it will be seen that the box is divided into two compartments, A and B, A containing the mechanism, and B the incandescent lamp. When a coin is inserted in the slot, S, it falls into a pocket, D, which is pivoted at E. The bottom of the pocket is closed by

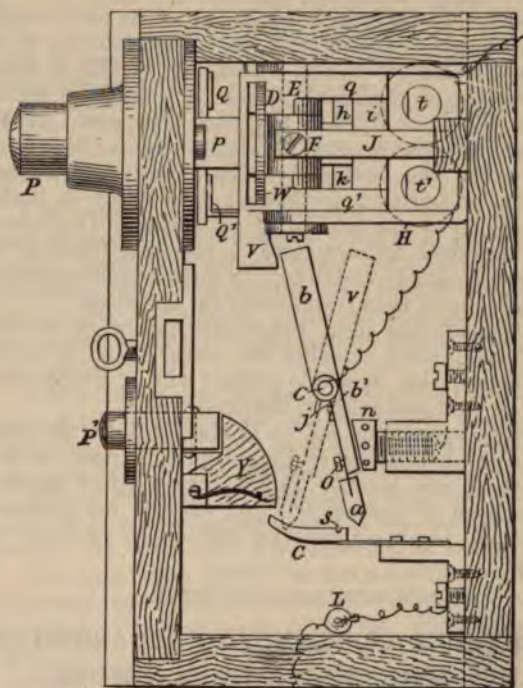


FIG. 2.

the lip, G, which forms part of the lever, F, which is also pivoted at E, its flange, I, being pressed against the partition, N, by means of the spring, J. Suppose the coin to be too small, the push, P, on being pressed would pass over it and strike against the projection, r, thus removing the lip, G, from the bottom of the

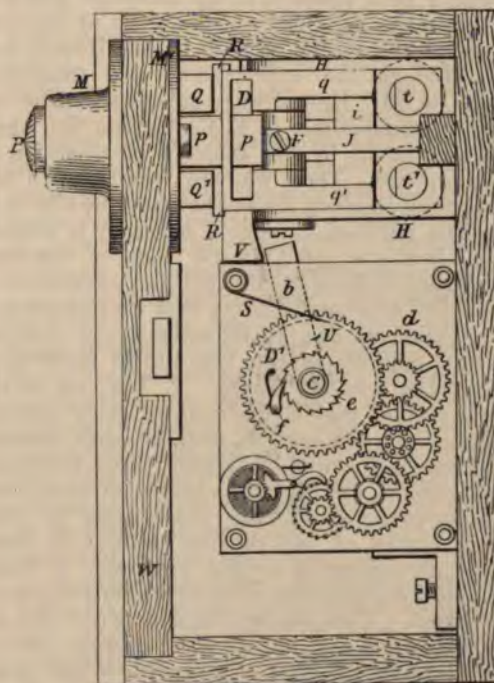


FIG. 3.

pocket, allowing the coin to drop into the receptacle, n, beneath the box, from which the operator can take it. If, however, the coin is large enough, the push, on being pressed, meets the upper part of it, and moves back the pocket, together with the lever F, until the armature, h, comes in contact with the pole of the electromagnet, t. Simultaneously, the projection, V (Fig. 2) of the pocket, D, moves the lever U round to the position shown dotted,

bringing a into contact with c . This completes an electric circuit through the electromagnet, t , ρ , and through the lamp, L , producing a light. The electromagnet being now excited, the armature, h , is held back, together with the lever, F , whilst the push, on being released, returns to its original position, owing to the action of the flat springs, Q , Q_1 .

The pocket, D , falls back by virtue of its own weight, allowing the coin to fall through the bottom into the shoot, K . It will be seen from Fig. 3 that the spindle, C , forms part of a train of clockwork, which is wound up by the motion of the lever U when the push is pressed. As the clock runs down the lever U slowly returns to its original position, when the contact between C and A is broken, the groove, S , causing a quick-break by holding A back a short time against the tension of its spring. The light is thus extinguished and armature, h , released, allowing the lever F and pocket D , to fall back to their original positions, the machine being then ready again for operation.

To extinguish the light before the clockwork has run down, P_1 is pressed, causing the piece V to strike the contact piece c , thus breaking contact with a , which extinguishes the light and releases the armature, h .

Should the apparatus fail to produce a light, the armature, h , is not held back, as the magnet is inert; so both the pocket, D , and lever, F , fall to their original position, the momentum of the weights, q , q_1 , causing the pocket to swing beyond the lip, g , allowing the coin to fall into the receptacle, n .

THE MAXIMUM EFFICIENCY OF INCANDESCENT LAMPS FOR CENTRAL STATION WORK.*

"This question, so far as it has to do with the Edison lamp, is one which has already received such exhaustive treatment by John W. Howell in his paper before the Institute of Electrical Engineers, April 14, 1888, and later by the Edison Lamp Company in a paper over Mr. Edison's signature, read at the last meeting of this association, that there would seem to be little left to discuss. An interested listener to Mr. Edison's paper at the last convention and to the discussion that followed it, my attention was particularly called to the apparent unwillingness of the convention to accept the results reached by Mr. Howell and Mr. Edison, though the experimental and theoretical determinations of Mr. Howell were substantiated by the mathematical determinations of F. E. Jackson, and these same results were found by Mr. Edison's investigation to be reached in practice. Those who are familiar with Mr. Howell's paper will recollect the law as stated by him to be as follows: 'The point of maximum efficiency is reached when the lamp bills are about 15 per cent. of the total operating expenses of the station.' It is the correctness of this law as applied to central stations that we propose now to consider. Following out Mr. Howell's line of thought, we find the total cost of operating lamps to be made up of two parts: 1. The cost of current. 2. The cost of the lamps. This current cost is made up of every expense incurred in producing the current, and properly includes material and supplies consumed, labour, taxes, insurance, salaries, rent, interest, and all fixed charges of every description. If, however, we examine these items we shall find that they consist of two distinct classes: 1. Those that vary with the amount of current produced. 2. Those that do not, but are practically constant without regard to the current output. Thus, among those expenses that are practically constant we will find all fixed charges, such as interest, rent, insurance, taxes; also nearly, if not quite, all the labour and salaries, since a station must always be ready to handle business. The variable items are supplies such as coal, water, oils, etc., and minor expenses. This latter class varies in practically a direct proportion to the current output.

"The breakage varies in conformity with the law obtained by Mr. Howell, that the life of the lamp in hours is equal to the sixth power or its efficiency expressed in

watts per candle. Using Mr. Howell's notation, and modifying it to conform to the divisions of cost as given above, we would have: T = total cost = $C + L$ where C = current cost and L = lamp cost, and where $C = C^k + C^v$ when C^k = constant current expenses and C^v = variable current expenses. Or $T = C^k + C^v + L$. Also, $T^v = C^v + L$, or total variable cost = variable current cost + lamp cost.

"To illustrate how the ratio between the constant and variable parts of the current cost will affect the total current cost under varying current output, we will take two cases of opposite character: 1. A , constant expense large; B , variable expenses small. 2. A , constant expenses small; B , variable expenses large. A central station belonging to the first class will be one where power is very cheap, or cost nothing at all, owns its water power, for instance, whose plant is well managed, which uses but little oil, etc., and has but few repairs. Under these conditions the total cost will vary but slightly whether there is one lamp in a circuit or a thousand. But while the total current cost varied but little, the cost per lamp or per horse-power per hour will vary largely with the current output. Thus, suppose 2,000 h.p. hours per month cost 400dols., of which 360dols. are for constant expenses and 40dols. are for variable expenses. Here the current cost per horse-power hour is 20 cents. If, however, we increase the output to 4,000 h.p. hours the expense becomes 440dols., of which 360dols. are for constant expenses and 80dols. for variable. Our current now costs only 11 cents per horse-power hour.

"A station in the second of the above classes will be one where the fixed charges are small, salaries low, and labour cheap. But fuel and water are high, or perhaps power is rented at a fixed price per horse-power hour so that the cost increases directly with the output. Thus reversing our figures about, suppose 2,000 h.p. hours per month to cost 400dols., of which 40dols. are for labour, salaries, taxes, etc., while 360dols. go to pay for fuel, water, etc. The cost would be as before, 20 cents per horse-power hour.

"Increasing the output now to 4,000 h.p. hours we would have total cost 760dols., of which 40dols. would be for constant expenses, while 720dols. would go to variable expenses. In this case the cost per horse-power hour would be 19 cents, as against 11 cents above, a widely different result. Hence care must be taken in dealing with the question of cost per horse-power hour under varying output of current, to examine and to divide it into its component constant and variable elements, and base our determinations upon the relative value of each."

THE TELEPHONE IN THE WEST OF ENGLAND AND SOUTH WALES.

The progress made with telephonic matters in the West of England calls periodically for a complete change of statistics. There is no beating about the bush, waiting for what turns up, but the management is constantly aggressive, seeking new fields wherein to increase its business, adding new links to provide the better for its subscribers, and generally to give every possible accommodation to its customers. It seems not long since we entered fully into the doings of the company, and yet it is necessary to return to the matter. The United Company, as far back as 1879 pretended to work Bristol, but it cannot be said with much success. They opened with 25 subscribers, now there are 438 exchange, and 94 private lines, or a total of 532. The statistics show that in 1888, as compared with 1887, the calls were 715,562, as against 625,631, an increase of about 90,000. Allowing the reply to each call, this represents 1,431,124 communications. At Plymouth the company's exchange has 265 subscribers, but perhaps the most instructive way to understand the work of the company is to give the statistics in tabular form, in which we get the history of the exchanges to August 3 this year (see Table A):

The company expect to have exchanges open and in working order at Gosport, Tavistock, Horrabridge, Radstock, and other places. In the following table we have indicated the towns in which the company encountered Post

*Abstract of paper read by Mr. Leigh Carroll at the Edison Convention.

Office competition by an asterisk. We may add, further, that at Newport the highest number of subscribers to the Post Office system was 44. It is now 35; the company having 98. In Cardiff the Post Office obtained 48 subscribers at one time, but have now only 33, as compared with the company's 142. Plymouth we have already spoken of. At Exeter the Post Office have had an exchange since the year 1883, but never succeeded in obtaining more than a dozen subscribers—at least so we were told—and have now closed their offices. The company, as will be seen, have, in just over two years or so, obtained 37 subscribers.

TABLE A.

Name of town.	Date of opening.	No. of exchange subscribers.	No. of private lines.	Totals.
Bristol	March, 1879	438	94	532
Bath	Oct., 1886	54	37	91
Gloucester	June, 1887	44	26	70
Newport (Mon.)*	Jan., 1886	98	26	124
Cardiff	Dec., 1885	142	53	195
Pontypridd	June, 1888	15	24	39
Swansea†	1887	153	34	187
Shrewsbury	June, 1887	28	29	57
Plymouth‡	Feb., 1885	265	63	328
Torquay	Oct., 1885	123	17	140
Paignton	July, 1886	21	4	25
Dartmouth	Jan., 1889	5	6	11
Totnes	Aug., 1888	3	5	8
Newton Abbot	Oct., 1887	7	1	8
Brixham	Feb., 1889	3	—	3
Exeter*	June, 1887	37	47	84
Portsmouth	July, 1885	186	68	254
Bournemouth	Nov., 1886	211	28	239
Poole		14	1	15
Southampton	June, 1886	100	22	122
Weymouth	June, 1887	25	20	45
Jersey	Nov., 1887	27	—	27
Cheltenham	Dec., 1888	36	17	53
Worcester	Dec., 1888	6	16	22

* Opened in face of Post Office competition.

† The Western Counties Company bought up the original Swansea Telephone Company, which had been in existence since 1881.

‡ As we have explained above, this was originally opened by the United Company in 1881 and reopened by the Western Company in February, 1885.

Since our previous article, a trunk line has been opened to Plymouth, connecting it with the other towns of the system, while Horrabridge and Tavistock will soon be connected with Plymouth, and thus in the system.

The following table B gives the route and wire mileage of the existing trunk lines between the various towns:

TABLE B.

Names of towns.	Route mileage.	Wire mileage.
Bristol—Bath	14	56
Bristol—Avonmouth	9	36
Bristol—Portishead	11	33
Bournemouth—Poole	6	36
Bristol—Sharpness	21	210
Sharpness—Newport	31	189
Sharpness—Gloucester	18	72
Newport—Cardiff	14	196
Cardiff—Swansea	50	264
Swansea—Llanelli	12	48
Interlocal group, Swansea, Briton Ferry, Morriston, and Landore	12	66
Newport—Pontypool	11	22
Pontypool—Tredegar and Merthyr	22	44
Merthyr and Aberdare—Pontypridd	15	60
Torquay—Paignton, Totnes, and Newton Abbot	15	18
Plymouth—Plympton	5	5
Gloucester—Cheltenham	9	18
Cardiff—Barry	10	20
Torquay—Plymouth	33	66
Torquay—Brixham	8	8
Torquay—Dartmouth	11	11

From this table it will be seen that the company have trunk wires in operation to the extent of 337 miles of route and 1,478 miles of wire. The same figures with regard to trunk lines in course of construction, which are expected to be opened for use at no distant date, read as follows:

Name of towns.	Route mileage.	Wire mileage.
Bournemouth to Southampton, Winchester, Portsmouth, and Gosport	72	144
Plymouth to Tavistock	12	12

or a total of 84 miles of route and 156 miles of wire. The total number of poles required for lines constructed and in course of construction has been 10,500.

The use made of the trunk lines will be seen from a perusal of:

TABLE C.

	Total message calls.	Renter's agreements and office calls.	Total calls.	A.
Opening Sept., 1887...	368	6,235	6,603	13,206
Corresponding month, Sept., 1888.....	1,447	12,150	13,597	27,194
Month of July, 1889...	3,041	12,431	15,472	30,944

A.—Number of messages or communications—i.e., double the number of calls, each call requiring a reply.

On January 19 last a span of wire 800 yards in length was erected over this river, at a height of 288ft. above high water mark. Silicium bronze wire No. 17 was used, weighing 24lb. for the span. We believe this span to be the longest in England. The working has been perfect, notwithstanding two heavy gales which have occurred since its erection.

The whole of the Western Company's trunk lines have been constructed of hard drawn copper wire, and are all metallic circuits. They have at present 183 annual renters on these trunks; in addition to which they have, of course, a revenue coming in from the public call offices in the various towns, where for a fixed toll anyone not a subscriber can speak with any subscriber to the system.

The tolls from Bristol to the undermentioned towns, or *vice versa*, are as follows, three minutes' conversation being allowed—viz.: Bristol to Bath, 6d.; Sharpness, 6d.; Newport, 6d. Beyond Newport, and as far as Pontypridd, including the towns in the loop, the toll is 9d.; and beyond Pontypridd, 1s. On the Bournemouth and Torquay trunks the toll is 4d. and 6d.

To show the use that is made of these trunks, we may say that the number of calls by annual renters during the month of July last was 12,040; by local subscribers from their own offices, paying toll, 2,068; and by the public from the call offices, 973; making a grand total of 15,081 for the month, representing the user of the trunks. That they are growing in favour with the business community is shown by the fact that the figures for the previous July (1888) were: Calls from annual renters, 10,703; local subscribers, from their own offices, 732; public from call offices, 559; total, 11,994—which is pretty conclusive testimony.

Whilst at the company's offices the representative of the *Electrical Engineer* talked over the trunk lines which radiate from Bristol. At 4.33 p.m. he rang up for Gloucester, distance 39 miles, got through in less than half a minute, and made a few enquiries as to the weather, etc. At 4.35 rang up Bath, 12 miles distant, and got answer at once. At 4.36 rang up Cardiff, spoke them, and at 4.37 rang up Newport, but found them engaged with subscriber. Then asked for Swansea, and got through at 4.39, *via* Cardiff. Then asked Swansea to switch through to Llanelli, distant 128½ miles, and spoke them at 4.40. So that in seven minutes conversation was held with five different towns widely divergent over a total wire distance of 363 miles. The conversation, in each case, was confined to two or three short questions and answers, chiefly referring to the weather, but quite sufficient to test the speaking properties of the lines. In each case the articulation was remarkably clear, and in only one or two instances was any repetition of a question necessary. Curiously enough, Llanelli, the furthest point spoken with, could be heard more distinctly than other places nearer at hand. This may, of course, have been due as much to the speaker as anything else. On the other hand, it should also be noted that the weather was very much against telephonic communication. There had been a strong gale over the district the night before, followed by heavy intermittent showers during the day, while every town rung up described the weather either as rainy or very damp.

The total number of the Western Company's employes is now 286, of whom 95 are switchroom operators, 71 of these being girls. Night work is done wholly by youths or men.

THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence ; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices :

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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"A. B. C."—A letter awaits you. Please call or send address.

IMPORTANT NOTICE.

We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No paper that we know ever refuses Subscribers or Advertisers. Nor do we; in fact, we invite them, believing that they will get full value for their money.

Specimen copies of the paper will be sent on request.

WEATHERCOCK AND BAROMETER.

Old-fashioned farmers used to toss up a straw to see which way the wind blew, but the weathercock roosted on the church-tower so as to be seen by all. So, again, the farmer would watch his sheep to foretell the weather, though the more scientific among them tapped the weather-glass. But the electrical engineer is better off than the farmer, in that he finds his weathercock and barometer dualised in the gasman. At any rate the gasman or his journals favour us every now and again as to the state of mind of the gas world on matters electrical. Is the forecast good electrically, then our contemporaries are snarling, are pretending that this is all moonshine, and that is evolved from the inner consciousness of the electrical engineer. One day the gasman is to study electricity, so as to be able to spring a mine on his antagonist; another day he is not to trouble, for everything plainly indicates that there is no danger now and no rocks ahead. Surely the gasman's mind is like the well-greased weathercock, changing its position with every passing breath of wind. Another significant indication of their fear is the avidity with which they find out and comment upon every trifling defect, and exaggerate every accident. You see conspicuously placed in type or hear reiterated in spoken words, Oh, call that a light: why it went out for two and a-half minutes on Friday night! or, There, believe that practicable: why a man was killed by it last week! Wonder what the record would be like if anyone in this wide world of ours, possessed of the *cacoethes scribendi*, hunted up all the failures of gas, or the accidents caused directly and indirectly by its use. Friends, don't be violent; don't rush so easily to stone throwing—you live in the most fragile of glass houses. Holes are easily made and easily mended, but a hailstorm is sufficient to shatter the house. Men and papers are most irresistibly funny in their weathercock action. To-day they feel that the insidious foe is really creeping along, and they have to count with it in their business affairs. But even these weathercocks and barometers are not perfect: they all indicate something, but not the same thing. That don't matter, however; the mere indication is sufficient to show the spirit is moving them. So when we find Mr. Livesey saying one thing, and his loving friend the *Gas and Water Review and Journal of Electric Lighting* saying just the opposite, we only conclude that something is causing unrest to both parties. Their views may be placed in juxtaposition. Remember, Mr. Livesey supports one school of gasmen, the *Journal* supports an opposition school, hence, perhaps, the blunt repudiation given. Mr. Livesey first:

"The promoters of electric lighting say that the numerous failures hitherto have been caused by un-

qualified persons being employed to do the work. Whether this be true or not, it is not necessary to enquire now; but is it quite certain that every gas manager, however well qualified he may be for his own occupation, is necessarily qualified for supplying electric light? Would the public be more likely to subscribe to electric lighting undertakings if they knew that the managers of gas works were to take charge of them, than they would be if they knew that the undertakings were to be placed under separate managements? Would it not rather deter persons from subscribing than otherwise? The best and most effectual opposition that gas companies can offer to electric lighting companies is to look closely to their own undertakings, and to keep down the price to the lowest possible rate consistently with the authorised dividend. Gas can be made in large undertakings at from 2s. to 2s. 6d. per 1,000 cubic feet, and then there are the products in addition. Let the electric light companies and the public know this, that they may see what they have to compete with; and they will not be disposed to risk their funds in such questionable undertakings. If the electric light companies can do better than this, they will win the day; but the prospect of doing so at present is not such as to cause any alarm to the owners of property in gas undertakings. It is often said that electric companies must succeed, because the electricity costs them nothing; but the same thing may be said of water, and yet water companies are never so prosperous as gas companies. Under the Electric Lighting Act of 1882 it was provided that, at the end of twenty-one years, the local authority might step in and purchase the undertakings compulsorily, if they saw fit. This was undoubtedly a very unjust provision; but the promoters had only themselves to thank for it. They professed to be able to do such marvellous things, and to 'wipe out' gas companies in such a very short time, that the authorities became alarmed lest the electric lighting should become a more troublesome monopoly than gas; and they consequently inserted this provision for the protection of the public. But as year after year passed, and one trial after another failed, and nothing was done permanently, the promoters, to account for their want of success, said the provision authorising the purchase after a period of twenty-one years deterred the public from subscribing to such undertakings; and that if the provision were repealed there was reason to believe that the public would subscribe freely. In consequence of that an Act was passed last session (1888), whereby the twenty-one years were extended to forty-two. The promoters are, therefore, now striving to make good their assertions about the public subscribing freely. The public, however, have a better knowledge of what can be done with electric lighting in 1889 than they had in 1882, and they have some

knowledge of the means by which those fabulous profits (if they can be called profits) were raised in 1882, and know also that there is no chance of repeating them now. Gas companies need not, therefore, have any anxiety about the result."

Thanks, Mr. Livesey, we know your opinion. Poor misguided electrical engineer, put up the shutters. Stop, let us hear what the *Gas Journal* says: "Mr. Wm. Livesey has had much experience in Parliamentary matters, and, like a true born 'gas-man,' he hates and detests the electric light, considers it a rival, and says that Parliament will not look with favour upon the application of gas companies for an extension of powers. We say, try! The 'interests' are *not* diametrically opposed. The supplier of gas is the person to supply the electric light, and if corporations owning gas works can do it, why not gas companies? Of course 'it will have to be done by a separate capital,' and be subject to stringent regulations, to prevent the profits of gas lighting being applied to making up the losses on electric lighting. But why should there be losses? We grant that if any company attempts to supply the electric light at the same price, light for light, as gas, enormous losses would be made; but why will gas people keep on at the silly argument that gas is cheaper than electric light? One man will be contented to wear a pair of Miles' celebrated 16s. trousers, whilst another will always pay 24s. It is just the same with lighting, and there is no need for any company, gas or electric light, to charge a price that does not return a profit. As a proof. For how many years have the Gas Light and Coke Company supplied two qualities of gas—coal and cannel! Did anyone ever hear the man who preferred cannel gas say he ought to have it at the price of coal gas? The argument is ridiculous; it will be many years before the electric light can be sold at as cheap a rate as gas, but the public will have it notwithstanding. . . . Let every gas manager take the advice given by the President of the Gas Institute, Mr. George Garnett, M.I.C.E., and later by the President of the North British Association of Gas Managers, Mr. G. R. Hislop, and make himself master of electrical science, and be ready when the time comes. We could look over the arguments of Mr. W. Livesey had they come from him as an individual, but when they are put forward to the world at large in a journal which is held in good repute, and has, presumably, a circulation amongst men of 'brains,' as coming officially from the 'Gas Companies' Association,' we consider the arguments deserve the remarks we have made upon them. Just one more word. Mr. Livesey says, 'Gas companies need not, therefore, have any anxiety about the result.' We protest that they need, and the comparisons given during the last few weeks of the working of several gas companies prove our

words. The falling off in sale of gas, and decrease in revenue is, unfortunately, kept back from shareholders, first by directors, and secondly by the absurd statements which appear in the *Journal of Gas Lighting*, emanating from an editing committee who are, at the very least, ten years behind the times."

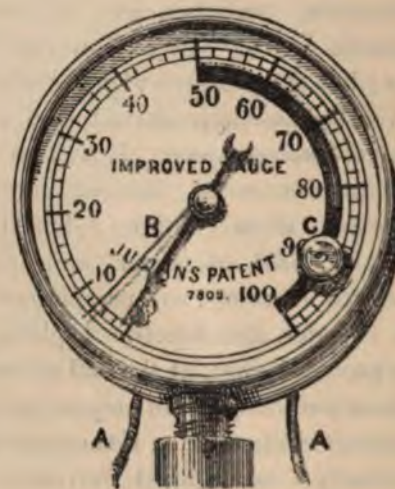
The *Gas Journal* has the courage of its opinions, and whenever they are towards the success of the electric light, the *Journal* increases its electrical matter till occasionally it is almost as wholly concerned with electricity as we are ourselves; or is it that whatever the *Journal of Gas Lighting* says is denied by the *Gas Journal*? Perhaps that is really the case, and the latter has no opinion of its own. Well, the two weathercocks or barometers always move at the same time, even if it be in opposite directions. Readers will probably say there is no moral to this article. Probably they are right, but we can't always stick the moral to the fable, and in lieu of doing this, we will pick one other bone with the *Journal of Gas Lighting*. That righteous paper is scandalised at the way in which electric light mains are laid in the Strand. It says:

"The slowness of electricians may be explained, as some observers have it, that they are not sure of their own plans, but have to learn as they go on. Or it may simply be that they are unused to this class of work, and fail to realise the requirements of main-laying in the heart of a crowded city. The worst of it is that the shopkeepers have no guarantee that the first nuisance will be the worst or the last. These electrical mains are a great experiment; and nobody knows how much trouble there may be with them on account of leakage. Thus, the Strand tradespeople have something to look forward to which may teach them when it comes that the putting of electric light wires underground is not an unmixt benefit."

Now, as a matter of fact, most of the difficulties to electric light engineers in the laying of mains are caused by the gas companies, who have laid pipes under the streets, and where these pipes have been discarded have not taken them up, but laid larger pipes in parallel lines, blocking up the greater part of the street. What right have gas companies to occupy half the street with dead pipes, and then to attack other people because the troubles arising from such pipes have to be overcome? Why did they not take up these pipes when they laid others alongside and had the pipes uncovered? Then, again, as to leakage. It is worthy of *Ally Sloper's* lunatic contributor. Why, of all the disgusting, diabolical stinks, commend us to the soil around gas pipes saturated by leakage from those pipes. If the existing electrical engineer cannot lay mains that will give a far less percentage of loss by leakage than gas mains, he ought to be annihilated.

JULIAN'S ELECTRIC ALARM GAUGE.

This steam-gauge is so constructed that an alarm is given when the pressure of steam in a boiler exceeds certain predetermined limits. There is a slot in the dial (vide illustration) in which a movable and detachable stud works. This stud can be set to any desired pressure, and is connected by a wire to one pole of a battery. The index hand, which is connected to the other pole, has a platinum wire fitted to it, so that when it makes contact with the stud at the predetermined pressure the circuit is completed, and a bell rung. Gassner's dry battery is used, and the bell is fastened to the battery-box, the connections being easily made. The negative wire from battery to gauge is coloured green, and the positive one white, so that no mistake can easily arise in connecting up, and the connections can be readily made by inexperienced persons. We understand that it has been thought well of by some of the principal ship owners after having been tested. It is obvious that when used on board ship, more than one bell can be connected with the gauge, so that alarms can be given in the captains, engineers, and other officers' cabins if necessary. The gauge might also prove useful in electric lighting stations on land, or, indeed, anywhere where steam power is used. By means of a peculiar arrangement of electromagnets, a slight pull, such as could be given by a small battery, can be made to operate a whistle. The alarm can, of course, be attached to ordinary steam-gauges.



It has been patented by Mr. Arthur Julian, of Basingstoke.

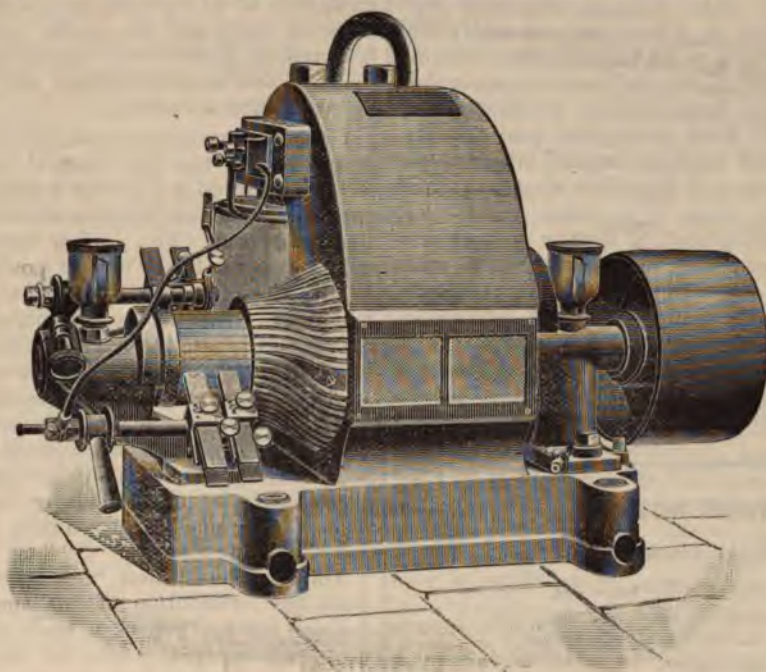
MACHINE DRIVING BY ELECTRICITY.

We have received a very well written pamphlet, fully and beautifully illustrated, upon "Machine Driving by Electricity," from the United Electrical Engineering Company (Messrs. Manville and Madgen, directors), of 3, Prince's Mansions, Westminster. The vast scope that electrical transmission of power is to play in the organisation of civilised life during the coming years can only receive sufficient attention at the present moment by the constant pressure upon the notice of those who are in command of the management and the extension of manufacturing concerns—that vast army of active and enterprising men which one meets in such places as the Bradford, Leeds, and Manchester Wool or Stock Exchanges, who are always on the alert to apply the best mechanical means at their disposal to the cheapening of England's products.

One of the means of introducing this is, of course, through exhibitions of machinery in motion, or of sample installations, where motors at work can be seen, and it is due to say that much greater development of the application of electric motors would be brought about if there were on exhibition in London a working specimen of these motors permanently on view, driving a printing press, a loom,

or a gold extractor, in the way that has been done to popularise the gas-engine. But, after this, the best way of bringing forward the question is to give good practical information, plentifully garnished with self-explanatory

machines as we have enumerated; that it requires little attention, and can be brought to the work instead of the work being brought to it. All these are well insisted upon in the pamphlet in question, illustrations are given, two

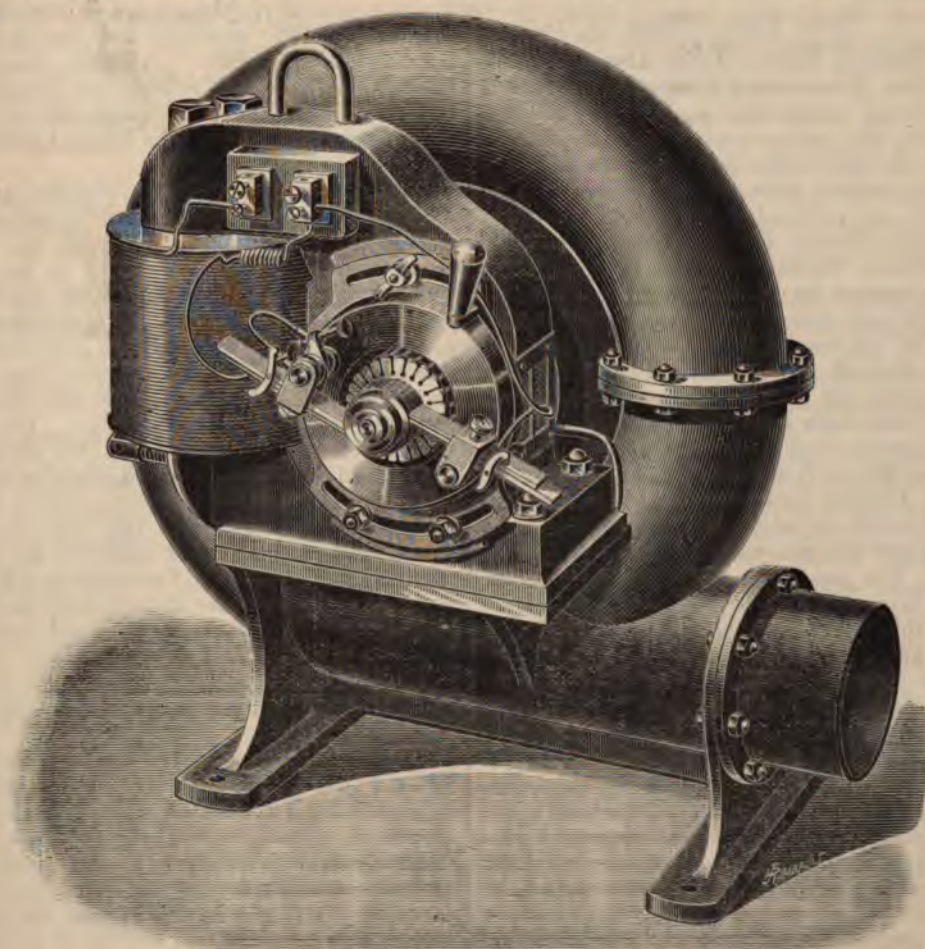


Electro-Motor, type A.

illustrations, such as appears in the pamphlet now issued by the United Electrical Engineering Company.

The great point is to show that energy now running to

of which we reproduce, showing the machines and their application, and sketches are given to suggest the employment in many particular trades, notice-



Electro-Motor Driving Fan.

waste can be utilised; that it can be run in and out, overhead, and round corners; that it can be brought any ordinary or even extraordinary distance; that a little engine no bigger than a coal-scuttle can drive such

ably that of coalmining, in all the branches of hauling and cutting underground, telphering above ground, and pumping the water from the mines. A one-horse motor, it is mentioned, weighs 150lb., and a five-

horse 450lb., and these figures give some distinct idea to readers to whom this is sent of what they may expect. Allusion is particularly made to use in shipyards, and for travelling cranes, while of course insistence is given to traction. The pamphlet ends with a long and suggestive list of the trades to which we may apply the motor; and now that electric central distributing stations shape well to become general, the publication cannot fail to interest manufacturers, hotel-keepers, warehousemen, and tradesmen alike. We must give great praise to the way in which the enterprise has been entered into, and all we can do, in the furtherance of the whole electrical engineering profession, is to hope that these efforts for the extension of the employment of electric motors due to the energy of this company, may be crowned with the greatest practical and financial success. Naturally the company insist somewhat upon special types of motors, in their case the Statter motor, illustrated above. The company have for some time had working business arrangements for these dynamos, and the good mechanical points of the machine are well shown in the illustration.

NEW YORK NOTES.

(FROM OUR SPECIAL CORRESPONDENT.)

*The Convention of Edison Companies.
The Consolidated Company now Ready to "Go Ahead."
Mr. Kennelly on the Heating of Conductors.
Other Papers.
America can actually Learn Something from Europe.
Panic on an Electric Car.
"Electrocution" Again.
Wires and Poles coming Down, Subways going Up.
A Jury of "Experts."
An Electric Railway Carriage Warner.*

NEW YORK, August 23, 1889.

Following the National Electric Light Association, the Association of Edison Illuminating Companies celebrated their tenth semi-annual convention at Niagara Falls last week. Some forty odd representatives of Edison companies scattered all over the country attended the convention, and six sessions were held. The proceedings are not made public, except to a limited extent.

At the first session, Messrs. E. H. Johnson and J. H. Herrick, of the Edison General Electric Company, expounded upon the reasons for the recent consolidation of the Edison interests, and stated that the parent Edison Company is now in the same position that some of its competitors have enjoyed for some time past—namely, that it is ready to enter the field to compete for business upon a commercial basis with the sinews of war behind it.

Several of the papers read were of purely Edisonian interest, but that of Mr. A. E. Kennelly, on "The Heating of Conductors by Electric Currents," doubtless contains information which would be valuable to all electric light engineers. The paper was not read, but "filed for action by the company." The paper was very lengthy, and contained numerous diagrams, curves, and tables, and it is considered a valuable addition to the company's technical literature. For the preparation of the paper, numerous experiments were conducted at the Orange Laboratory. These experiments were divided into three parts: 1. The heating of copper wires, both bare and insulated, encased in wooden moulding to represent house wires. 2. The heating of copper wires, both bare and insulated, suspended on poles in the open air to represent overhead wires. 3. The heating of copper wires and strips suspended across a room to represent the conductors in an electric light station, and also to form a connecting link between the two previous conditions.

Other papers of general interest were on "The Maximum Efficiency of Incandescent Lamps for Central Station Work," "High Potentials as an Adjunct," and "The Motor Question."

American tanners are beginning to take an interest in the newly-developed industry of tanning by electricity. When it was first reported from Europe that leather was being tanned by electricity, and the process thereby con-

cluded in about 24 hours, American tanners regarded the statement as a newspaper sensation, and looked upon the process as a sort of transatlantic offset to our electric sugar refining. Now, however, that they are convinced that tanning by electricity is an assured fact, they view the matter in a different light, and one of the largest leather dealers here has recently decided on a trip to Europe to learn something more of this latest revolution which electricity has worked in established industries.

One night early this week an accident happened to one of the cars on the new electric tramway at Newport, to which I referred in a previous letter. A man jumped from the car while it was running about eight miles an hour after just descending a hill. A cry was raised that a man was off, and the conductor put on the brakes and reversed the motor. The headway of the car acting against the reversed motor had the effect of wrecking the brushes, a short circuit was produced, and the commutator burst, fragments being thrown up into the car through a trap used for oiling. A panic ensued among the passengers, and eight jumped off, while twelve more sensibly retained their seats until the car was brought to a standstill a short distance further on. Nobody was seriously damaged except the originator of the panic, but the accident gives the wealthy pleasure-seekers who opposed the building of the road a chance to say "I told you so."

The excitement over "electrocution" has disappeared since the termination of the enquiry, and the referee's decision has not yet been made known. The young men who write up paragraphs for the daily press, however, occasionally devote their energies to raking up the matter again and unearthing phases of the question "unknown to the general public." Last week the *Herald* published an article stating that the general impression in "electrical circles" was that Mr. Cochran, the counsel who worried Mr. Harold P. Brown to such an extent, and pulled the experts to pieces generally, although acting ostensibly for Kemmler, the condemned criminal, was really retained in the Westinghouse interest. Another daily criticises Mr. Brown's purchase of Westinghouse dynamos with which to perform the execution, and states that as he is inimical to the Westinghouse system he hopes to discredit it in the public mind by such a use.

The wires are coming down, and the subways are going up. The work of removing the wires and poles from Lower Broadway progresses rapidly. All the wires which are being taken down are dead wires of the Western Union Company, underground substitutes having already been placed in the new subways. It is estimated that there are over seven miles of wire between every two poles on each side of Broadway, so it will be seen that their removal is no insignificant job. Wires are also being pulled down along the main streets of Brooklyn. The improvement in the aspect of the streets with the disappearance of the wires and poles is very marked, and the occupants of offices in the upper floors of Broadway say that they are greatly benefited by increased light and fresh air, the free passage of which was formerly obstructed by the mass of wires in front of their windows. The subways still continue to give trouble. Last Saturday one exploded in the upper part of Broadway. The loud report caused considerable excitement, but very little damage was done. This is the second explosion within the last few weeks, the scene of the previous one being only a short distance from that of the latest disturbance.

An inquest was held a few days ago back in the case of Edward Quinn, a foreman of the Brush Company, who was killed last June by a shock at the Brush central station in New York. The coroner's jury was largely made up of electrical "experts" (a term very loosely applied here), and after an hour's debate a majority of them decided to censure the company. The censure was because the company did not replace a switchboard that was out of order. The minority refused to censure, but recommended that in future electric lighting companies be required to provide duplicate switchboards, and to compel all employes while engaged in manipulating wires to use rubber gloves, such as outside linemen wear. The censure of the majority seems somewhat unjust towards the company, as it was reported when the accident happened that a dispute had arisen as to

whether a certain wire in the station was a "live" or a "dead" one. Quinn declared that it was "dead," and to prove this, he seized an earth wire, and ascending a ladder, grasped the end of the wire in dispute. It turned out to be very much "alive" and killed him, but the result would have been the same if he had been provided with rubber gloves, as he would have had to take them off in order to make such a risky experiment. Moreover, to "compel" an American workman to adopt precautions of any sort is no such easy matter.

An ingenious electric heater, invented by Dr. Leigh Burton, is just now being introduced by the Burton Electric Company, of Richmond, Va., for warming railway carriages, apartments, etc. The heater consists of coils of resistance wire embedded in dry, powdered clay, the whole enclosed in a cast-iron case provided with knobs to increase the radiating surface. Current is supplied to the heaters at a pressure of 80 volts, and each heater takes about $2\frac{1}{2}$ amperes of current, the resistance of the coils being 35 ohms. It has been found by experiment that such a current raises the temperature of a heater about 200deg. F. For railway carriage warming it is proposed to place the heaters under the seats of the carriages, the necessary current to be supplied by dynamos driven from the axles of the coaches. These heaters, once constructed and installed, are expected to be permanent fixtures, requiring no further attention. The moderate rise of temperature produced precludes all danger of fire, and it is impossible for the resistance wires to be burned unless the surrounding clay is raised to the burning temperature of the wires.

THE HEATING OF CONDUCTORS BY ELECTRIC CURRENTS.*

Mr. Kennelly stated, in presenting his paper to the association: "Not very long ago the Edison parent company desired to know more fully than it had the means of knowing at that time the exact conditions of safety as regards the carrying capacity of conductors used in electric light work and the transmission of electrical energy for power purposes. The subject was first suggested specifically to the Standardising Bureau by Captain William Brophy, of the New England Insurance Exchange, who pointed out certain inaccuracies and omissions in the existing tables used by the various electric companies in wiring buildings and forming the foundation of the rules of the exchange under which these companies are operating.

"It is, of course, a very important subject, and when the insurance people applied to the Edison Electric Light Company for information, it was unable to give full and complete details of what sizes of wire should be considered perfectly safe for any given current under any given conditions in household work. Thereupon the Light Company had carried out at Mr. Edison's laboratory in Orange a series of experiments which have resulted in putting the company in possession of more full information upon this and kindred points than is to be found anywhere else in the electrical world at this moment.

"In these experiments we adopted the course of putting 24 wires of different sizes in actual panelling. Various currents were then sent through these wires, the highest being 300 amperes, which was considered a maximum for general interior work. Observations were made as to the temperature resulting from these various currents. The highest temperature reached was 100deg. C., or about 180deg. F. above that of the surrounding air of the room. This was reached by No. 26 B.W.G. wire with nine amperes. As the wires grew bigger and bigger the temperature lowered correspondingly with the same current until with the largest wire only 40deg. C. was reached with 300 amperes. By taking these results we can find what temperature will be reached by any current on a given size of wire under ordinary conditions. The important question arises as to what is considered a safe temperature. You might allow a wire in your cellar to rise 150deg. F.

* Abstract of paper by Mr. A. E. Kennelly, read at the Edison Convention.

above that of the surrounding air, which might be 40deg.; that would be in all 190deg. You could not allow at the ceiling of your parlour, where there might be an existing temperature of 100deg., 150deg. more on top of that without a source of danger."

The following are a few extracts from the introduction of the paper: The subject of the dimensions which a conductor should possess for the economical transfer of a certain quantity of electrical energy to any given distance is of paramount importance to the electrical engineer. Among the leading pecuniary considerations involved—namely, the price of power, cost of the conductor, together with its maintenance, and the rate of interest and depreciation on its value—factors which under certain known reservations are economically connected by Sir William Thomson—the amount of a current which a conductor can safely carry without overheating is not taken into account, for the reason that under existing prices, and with ordinary current strengths, the strictly economical conductor is of such a cross-sectional area that its overheating can only be due to unforeseen and accidental causes. There are, however, in practice very many cases where economy is not the first consideration, or where the limits of economy have been necessarily exceeded, as, for example, the ordinary case of maintaining a constant difference of potential over a system of electric light mains under all conditions of variation in load, conditions which may and often do test the carrying capacity of parts of the system to their limits, and thus the necessity of knowing the safe limit of load upon any conductor has become fully recognised.

Notwithstanding the importance of the subject, our generally available knowledge of the safe limits of conduction has hitherto been but scanty. This has been partly due, no doubt, to the exceedingly rapid development of the science and art of electrical transference of energy, and the more pressing need for all the activity of its votaries in the other more advanced directions; also the complication and difficulty which beset all problems connected with the movement of heat has no doubt had its share; but the facts are that up to the present time we have not known with any pretension to accuracy what degree of elevation in temperature would be produced in a conductor by the continued passage through it of a given current strength, and as to how that temperature will vary with the insulating covering of the conductor or its environments.

The only important contributions to the subject seem to have been embodied in two very excellent papers, one read by Mr. W. H. Preece before the Royal Society of Great Britain, in which the current strengths required to fuse wires of different metals and diameters is ably determined and discussed, and the other read by Prof. George Forbes, before the Institute of Electrical Engineers, London, in March, 1884, in which the subject is fully considered from a theoretical point of view. Prof. Forbes, seems, however, to have had little experimental data at his command at that time, only fifteen actual observations being given; and although the formula and calculations are mathematically unimpeachable, the results are wide of the mark, owing to the fact that the coefficients of cooling taken by him in the absence of direct observations were determined under other conditions, and were not fairly applicable. This, Prof. Forbes himself suspected, but was unable to remedy.

The general state of our knowledge up to this time can best be reviewed by an examination of the current rules and statements in the latest books of electrical engineering. In this year's edition of Munro and Jamieson's pocket book, the only rule given for electric lighting leads is for ship use—viz., one square millimetre of section for every ampere and a half of current. This is equivalent to about 970 amperes to the square inch, or 1,315 circular mils. to the ampere. That is certainly a safe conductor up to a diameter of half an inch under practical conditions, but it is not by any means an economical rule for wires less than half an inch in diameter. The British Board of Trade rule requires 2,000 amperes per square inch for currents up to 10 amperes, and 1,000 amperes per square inch for currents above 10 amperes. To this rule similar remarks apply.

To determine the safety limits of conductors under practical conditions by actual trial, a series of experiments has been made for the Edison Electric Light Company, at Mr. Edison's laboratory, Orange, N. J., and the results obtained not only enable us to predict, with very fair accuracy, the carrying capacity of any ordinary conductor for house wiring or overhead purposes, but have also elicited several matters of interest and value.

The experiments were naturally divided into three parts, to be described separately: 1. The heating of copper wires, both bare and insulated, encased in wooden moulding to represent house wires. 2. The heating of copper wires, both bare and insulated, suspended on poles in the open air to represent overhead wires. 3. The heating of copper wires and strips suspended across a room to represent the conductors in an electric light station, and also to form a connecting link between the two previous conditions.

The rule recommended by the committee of the London Institution of Electrical Engineers for the prevention of fire risks in electric lighting as published last year was: "That the conductivity and sectional area of any conductor should be so proportioned to the work it has to do that if double the current proposed is sent through it, the temperature of such conductor shall not exceed 150deg. F." Assuming, in the absence of reasons to the contrary, that this rule is the best to adopt, and, taking the mean temperature of the air in a house surrounding a panel as 75deg. F., the rule demands that the temperature elevation shall not exceed 75deg. F., or 41.7deg. C. It is thus the proposal of this paper to fix the safe current as that whose double will bring the temperature elevation to 40deg. C.

The table appended shows that whatever temperature be adopted as the safety limit, the principle of fixing the diameters of conductors by allowing a certain number of amperes to the square inch or a certain number of mils. to the ampere can only be very imperfect, unless a sliding scale be arranged. Thus the diameter of wire which just falls upon the Board of Trade rule is 0.505in. for 200 amperes. According to the plan here adopted this rule would not be a safe one beyond that diameter and current, while for smaller wires it would, so far as safety is concerned, be very uneconomical.

A wire in wooden panelling when heated by a current is cooled by convection under complex numerical conditions. As the temperature of the wire and panel rise, radiation and convection gradually come into play.

A bare wire in the still air cools by radiation and convection. The radiation follows along the law of Dulong and Petit, and is given in the accompanying table and curves. It varies also with the surface nature of the wire, and also, strictly speaking, with the surface natures of the bodies by which the wire is surrounded.

A bare wire in air out of doors is subject to a very great increase of convective cooling even in calm weather.

ELECTRIC RAILWAYS.*

BY GEO. W. MANSFIELD.

The application of electricity to street railways has been so rapid that we are liable to lose sight of many valuable points in our herculean efforts to supply the demand. Those who are engaged in it know that they let many opportunities slip by. They cannot help it. The more generally, however, the points are known the quicker will be the reward to some directly, and to them indirectly.

The application of electricity during the past decade have been astonishing. In the face of an industry a half century old, and of enormous wealth and power, it has won the leading position. In every direction that honest effort has been made, it has succeeded. Commercial barriers have been broken down and physical obstacles swept aside. When once the feasibility was demonstrated the end could not be predicted.

For the transportation of the people in the streets of our towns and cities the demonstration has been witnessed, the application made, and a wonderful luxuriant growth started. There is no industry so far reaching in character, so vital

to a community's interests, and yet one so little known as the street railroad business. Neither the scientific world, the commercial world, nor the people themselves, have realised its vast importance. Eliminate the horse car from every city or town in the Union and forecast the results.

In 1828 the now great Baltimore and Ohio Railroad started and horses were used to draw the cars. This might be called the first horse car line in the United States. In 1830, there were 12,866,020 persons in the United States, and not a mile of street railroad nor scarcely of steam road. As a rule, the New York and Harlem Railroad, incorporated in 1831, is spoken of as the first street railroad in the country. The first car was run in November, 1832, from Prince-street to Harlem Bridge. In 1837, it temporarily succumbed to steam cars, but resumed in 1845.

The census of 1850 gives our country a population of 23,191,876, and published history but one street railroad. The child had been born, however, and in 10 years the street railroad was in almost every city of any magnitude in the country. To what has this child grown? In 1880, our population was 50,155,783. Estimating on an increase of 33½ per cent. in 1890, or six months hence, the population will be 66,874,354. For the transportation of this number of people in the streets of our cities and towns the most accurate figures it is possible to obtain show the engagement of about 425 companies employing 28,000 cars, 125,000 horses, and operating some 3,500 miles of track. The capital invested is variously estimated from 175,000,000dols. to 200,000,000dols.

The number of passengers carried is so enormous that it is impossible to obtain figures of any great degree of accuracy. As a result of most careful compilations and estimations it is reasonably sure that at least 1,500,000 passengers are transported.

Still more striking is the importance of the street railroad business when compared with the magnitude and extent of the steam railroads of the United States. The figures of 1887 show a tabulation of 147,988.60 miles of railroad and 20,582 passenger cars, and passengers carried but 428,225,513. With nearly an equal number of cars and 42 times more road, only ¼ as many passengers were carried. Behold the yet more amazing figures: The horse cars of the City of New York carry 199,491,735 passengers, almost half as many as are carried by all the steam roads in the United States. If to this number are added those carried by the elevated roads we have the total of 371,021,524, or almost as many passengers are carried in New York City alone as are annually carried by all the steam roads in the whole United States. The street railroads of the State of Massachusetts carry over 44,000,000 more people than all the steam roads in that State. One road alone, the West End of Boston, carry nearly 10,000,000 more than all the steam roads combined.

To show somewhat in detail where this tremendous traffic is, I have prepared table I. Most of the figures showing passengers carried were obtained from reliable sources, and the balance were estimated from an average obtained from those I was sure in regard to.

If you figure for each car 6 h.p. of electric energy, it will give you a rough idea of the size of an electric central station needed to operate all the cars. In New York City, dynamo capacity of 13,800 h.p. would be demanded, in Boston 9,504 h.p., and so on. This is destined to come as surely as the days succeed each other. In Boston it has come, and a station of approximately 8,000 h.p. is already in the hands of the engineers.

If the conservatism of Boston permits it, how can the result be but inevitable for the other great cities of the Union? This enlightened age will have these facilities for transportation, and as soon as it is possible and wise. The universal cry to-day in almost every large city the length and breadth of the land is for cleaner, surer, and more rapid transit.

Unfortunately the tendency of the times is to concentrate in or around large cities. This means congestion with all its deplorable results. The solution lies to a very large extent in the street railways. These must be the cities' arteries and veins extending from the heart in all directions to its extremities. Improve then the street rail-

* Paper read at the National Electric Light Convention at Niagara Falls.

TABLE I.—CITIES OF 1,000,000 POPULATION AND OVER.

Name.	Companies.		Miles single track.	Total trackage.	No. of cars.	No. of horses.	Locomotives.	Total passengers carried.
	Elevated.	Horse.						
New York	2	...	60	89	948	...	291	171,529,789
Brooklyn	3 miles cable included.	19	143	268	2,300	14,441	..	199,491,735
Boston	3	1	24	35	247	...	91	105,975,249
Providence	...	1	211	231	1,534	7,684	...	18,632,082
Chicago	44 lines in one system.	7	54	54	289	1,414	...	97,039,919
Philadelphia	...	12	325	325	2,400	8,279	...	15,582,732
St. Louis	3 cable.	14	302	326	1,512	7,322	8 dummies.	99,348,000
Baltimore	...	12	169	169	1,058	4,231	...	143,433,959
Cincinnati	2 cable.	30 lines 7	158	158	460	3,167	...	50,772,000
New Orleans	...	7	164	164	530	2,644	4 dummies.	34,837,000
San Francisco	2 steam. 8 cable.	10	140	140	499	2,019	18 dummies, 7 loco.	31,728,000
Buffalo	...	2	163	164	707	1,724	3 loco.	24,228,000
Washington	...	5	39	56	198	1,276	39 dummies.	130,860,000
Newark	...	3	63	63	336	1,684	...	13,108,203
Louisville	...	2	53	53	219	1,264	...	21,892,000
Cleveland	...	7	112	112	378	Mules, 2,270	...	15,168,000
Pittsburgh	6 cable, 1 elec	13	123	123	523	Horses, 2,521	...	24,970,000
Jersey City	...	2	113	113	347	1,924	3 dummies.	30,252,000
Detroit	3 elec.	4	35	35	132	825	...	39,088,000
Milwaukee	...	3	65	65	263	1,682	...	10,725,000
Albany	...	3	68	68	208	1,188	2 Loco.	32,184,000
Indianapolis	Consol'd.	1	19	30	103	424	...	16,744,000
Kansas City	6 cable.	7	40	40	99	648	...	4,278,927
St. Paul	1 cable.	1	124	124	469	613	38 dummies and motors.	9,720,000
Omaha	2 cable, 3 elec.	1	74	74	154	816	...	33,969,000
Minneapolis	Con'd.	1	61	61	167	580	24 motors	23,608,000
Totals	...	189	3,103	3,414	18,645	77,884	...	20,540,000
								14,352,000
								1,434,057,595

Five elevated roads, 27 cable, 147 horse, 7 electric, 3 steam and horse combined—189, total; 18,645 cars, 394 locomotives, 134 dummies and motors; 77,884 horses, 2,270 mules—80,154. About 24,000 horses are annually disabled.

ways. Almost every method of applying energy to street cars has been applied, and they all have finally "bitten the dust" in the great battle for life.

The Baldwin Locomotive Works have for years been engaged in the manufacture of steam dummies for street railways.

Unquestionably through them the highest order of talent and skill has been lavished upon the solving of the vexed problem, as to how to use steam for the haulage of street cars. Motors weighing from 13,000 to 27,000lb., when in working order and ready to run, have been built. In most cases two engines have been employed, with cylinders and strokes ranging from 8in. by 10in. to 12in. by 16in. The power of these engines can be judged from their pulling capacity, which varies from 320 tons to 634 tons on a level, and from 16 tons to 43 tons on a four per cent. grade. Ordinarily they were built to seat from 15 to 20 people.

The wheel base was generally 6ft. and the wheels 31in. in diameter. Naturally, they were built to run at speeds from 10 to 15 miles per hour, and to be provided with all possible safeguards and conveniences.

Powerful brakes were used, coke was burned to avoid smoke, mufflers provided for the exhaust and safety valves, and every other possible contrivance adopted to eliminate all objectionable troubles. Their economy in working has not been very freely published. From reliable and authentic sources, we learn that the lowest fuel consumption is 6½lb. of coke per mile run. The average is from 10lb. to 12lb. when ordinary grades are ascended. The total cost of operating per mile has been in some instances reported to be put 3½c., but in other cases it was found to be over 20c. per car mile. It is needless to say that in spite of all the skill, time, and money spent upon them, they have not proven, except in a few isolated cases, either satisfactory or economical.

Electricity, the youngest of them all in application, shows already the sturdy, vigorous growth that inevitably will result in its complete supremacy.

TABLE II.—Electric Street Railroads.

					Jan. 1-July 1, 1889.			
	1885	1886	1887	1888	Operating.	Building.	Ttl.	Ttl.
No. of electric railways..	3	5	7	33	19	42	61	109
No. of miles of road	7.5	28	29	130.5	113	267	380	575
No. of cars	13	39	81	265	174	364	538	936

The figures of table II. certainly show that the facts warrant the prediction. They were most carefully prepared and include every road of any record. It does not show it all either. That remarkable contract which the West End Street Railway Company, of Boston, the largest street railway company in the world, signed recently with the Thomson-Houston Electric Company is not included under the heading "roads building in 1889."

I think that this contract in responsibility and importance is one of the greatest that has ever been signed in the history of electricity. In electric railroading it is the greatest and probably will be for many years to come.

The West End Street Railway Company, of Boston, owns 217 miles of track, and 1,584 cars, all of which are to be equipped so as to be operated with electricity. Add these to the list, and how does our list stand? If it be within the bounds of the supply men, at least 75 miles will be built this summer, and 100 or more cars equipped. Will not this give the electric railroad industry a standing warranting the attention of the whole railroad world?

	1870.	1880.	1890.
Total h.p., both water and steam, engaged in the whole manufacturing industry of the United States	2,346,142	5,410,837	Estimat'd 5,255,582
Total h.p. engaged in the electric lighting and power industry	0	1,000	500,000
Total h.p. engaged in electric railway industry	0	0	30,000

As an interesting comparison regarding the new industry, if I may call it such, note the figures in the preceding table.

In meeting this demand of the age for better transit there are many considerations that claim our most careful attention.

The conditions to be met are widely different from all other electrical applications. Essentially we have, first, a steam-engine; second, a dynamo; third, a conductor; and fourth, a motor mounted upon a vehicle; and subjected to mechanical and physical conditions more extreme and severe than ever heretofore has been imposed upon any piece of electrical machinery. In the battle for success the engine has to stand the bulk of the fighting. Anything wrong with it affects directly the electric system, and in many cases it has also to stand the blows if anything is wrong with the electrical system. Dr. Bell has pointedly shown in his valuable paper many well-known facts, and clinched them by figures taken on one particular road. They can be taken with certain allowances as fairly representing the conditions imposed upon the steam-engine by an electric road.

The extreme liability of short circuits on the road from falling wires, careless drivers turning the current on too suddenly when starting, and a variety of accidents that may happen on the very best roads, render of the first importance that the engine have its main moving parts at least 20 per cent. heavier than ordinarily. Under the extreme fluctuations of load, keys, nuts, and bolts will work loose. An engineer in a large station recently told me that he practically took to pieces and put together nearly every month a 100 h.p. engine running an 80 h.p. dynamo, whereas prior to the time it had been connected to a railway dynamo it had given practically no trouble, although worked well to its capacity.

Hanscom, of cable railroading fame, writes: "We do not consider it good engineering to design an engine to suit the general average of all lines in the country." He argues special engines for every road. Mr. C. B. Holmes, president of the Chicago Cable Company, writes: "I would recommend that the strength of parts and weight of fly-wheel be at least one-third greater than the usual run of engine power." Our business is analogous, and I think we should heed their counsel.

A compound engine rated at 109 h.p., running an 80 h.p. dynamo, under test recently gave the following: Friction card with dynamo but no current, 11.65 h.p. Aggregate horse-power of cards, 1,247.74 h.p. Average horse-power of cards, 56.67 h.p. Maximum card, 120.79 h.p. Minimum card, 15.56 h.p.

The cards were taken at 10 minute intervals for four hours. There were at the time three electric cars on the line, each towing another. As the day was a pleasant Sunday, every car was crowded.

During the same time current and potential readings were taken on the line at the station. The average gave 30 h.p., or an average efficiency of 54.6 per cent. for the total time. Every moment deducted that no current was flowing would raise this efficiency. At times the efficiency was far higher than this.

The road conditions were severe, the grades ran as high as 10 per cent., and had numerous others of five and seven per cent. The extreme current fluctuations were noted in one minute's variation from 45 amperes to 140. The potential was very constant.

On another small road the extremes varied from the friction load to nearly 85 h.p. on an 100 h.p. engine. These extremes would happen even during the time a three impression card was being taken. Under such conditions the question of coal economy is a troublesome one. On large roads, unquestionably a far better showing would be possible.

Laying aside the question of coal economy, which is cheap in comparison to food for horses, the best engine is the one that handles the average work with the least repairs. On some small roads the ratio of engine friction to average daily load may be large. The great majority of roads, however, will have a sufficient number of cars to so reduce the ratio of extremes to the average load that the engine can work at its most economical point of cut-off

the major part of the time, and raise the average load to such a point above the friction load that the per cent. lost will be comparatively small.

Almost the first question asked by the manager of an electric light company, when an application has been made to him for power, is: "How much electric power must I allow per car?" No man can give a definite answer to this question that will meet all conditions.

If the following facts are known a fair judgment can be made, although I am much afraid that the accuracy of the judgment would not be a William Tell: (1) Number of cars simultaneously operated. (2) Speed and nature of service. (3) Maximum grade, and number of grades. (4) Scheduled location of cars in reference to grades. (5) Motor cars to be used to tow other cars or not. (6) Any peculiarities in regard to the distribution of cars. (7) Condition of track. (8) Location of track in reference to power-house. A moment's thought over any one of these points, I think, will convince you of its importance.

On a portion of the Cambridge division of the West End Street Railway Company's road, of Boston, the Thomson-Houston Company's motors commenced running February 16, 1889. Up to July 1, 165,781 miles, and 25,505 round trips had been made, with a loss of but 325 miles, or .19 of 1 per cent., and 49 round trips, or the same per cent. of loss. During this time nearly 1,500,000 passengers were carried. This, in view of the fact that during the entire time one and part of the time two tow cars were drawn, is remarkable. It must also be known that the route extends over one of Boston's most crowded business thoroughfares, and is the main street connecting Cambridge and Boston. On a portion of the route there is an open bridge, about 1,800 ft. long, on which is located one draw, which is opened from 20 to 30 times per day.

Over this bridge 1,800 cars per day passes, or on the average of one every three-quarters of a minute, and at some portions of the day they run at half-minute intervals. The teaming on this street is also very heavy, necessitating constant stopping.

You will see from these figures what the loss of current or a motor burnout causing delay would mean. Our record, however, has been magnificent.

As the dynamos are run by the Cambridge Electric Light Company, and are so arranged that the same engines furnish power and lights for their own purposes, as yet only approximate data as to the fuel consumption, etc., has been possible.

A few electrical tests have been made, as well as it were possible. Ammeter and voltmeter readings were taken at the station every 15 minutes, four readings per minute, or at 15 second intervals. This was kept up from 6.30 a.m. to 12.30 a.m. next morning for five days. In all, 1,480 readings were taken. The average of these readings gave for 12.6 cars in continuous service, 111.6 amperes, 500 volts, or 74.8 h.p. Per car this is 8.8 amperes and 5.9 e.h.p. The average number of passengers carried was about 58 per round trip.

(To be concluded.)

ELECTRIC LIGHTING OF THE THAMES' STEAMERS.

The Victoria Steamboat Association, Limited, whose passenger steamers running on the River Thames are now so well known, have recently taken a step which will doubtless be greatly appreciated by the travelling public—namely, the electric lighting of certain of their vessels. Those persons who frequently avail themselves of the company's steamers have constantly complained of the poorly lighted condition of the cabins, whilst the decks have, so to speak, had no artificial illumination whatever, excluding, of course, the starboard, head, and larboard lights. These complaints should now never be repeated, as the association have already had four of their steamers electrically lighted. Messrs. D. Mackie and Chalmers, of Turk's Head-yard, Turnmill-street, London, E.C., have fitted up the installations to the great satisfaction of the company. The steamers lighted are the "Alexandra," which runs from London Bridge to Gravesend and Sheerness; the "Glen Rosa," plying between London Bridge and Clacton-on-Sea; the "Duke of Edinburgh," which runs from London Bridge to Sheerness; and the "Cardinal Wolsey," travelling between London Bridge and Hampton Court.

The installation on the "Alexandra" was put up last year, there being 30 lamps of 16 c.p. The dynamo, which is of the firm's usual type, has an output of 30 amperes at 65 volts, and runs at 650 revolutions per minute. The engine is a 3 h.p. nominal Tangye steam-engine, running at 230 revolutions, the steam for which is furnished through copper piping from the steamer's boilers. Of the 30 lamps, which are suspended from short copper fittings, and which are enclosed in circular frosted glass protectors with copper wire guards, eight are installed in the aft saloon, five under the awning which is placed over the aft deck, four in the fore cabin, and the rest in other portions of the vessel. On the "Glen Rosa" 19 lamps of 16 c.p. are put up, and of these 7 are placed in the aft saloon, and four in the fore cabin. A Hindley engine of 2 h.p. nominal is employed, and this runs at 230 revolutions, steam being in this case also supplied from the ship boilers. The dynamo runs at 1,500 revolutions, and gives 30 amperes at 50 volts pressure. On this steamer the lamps are encased in longitudinal frosted glass protectors having a semi-circular base and copper wire guards. The number of lamps on the "Cardinal Wolsey" is 17 of 16 c.p. A 2 h.p. nominal Tangye engine is used, running at 250 revolutions. The output of the dynamo, which runs at 1,450 revolutions, is 22 amperes, the E.M.F. being 50 volts. Four of the lamps are installed under the awning in the aft of the vessel. The lamps have nickel plated fittings, and are enclosed in frosted glass protectors with wire guards, similar to those on the "Glen Rosa." The "Duke of Edinburgh" has installed 19 16-c.p. lamps, four of them being fitted up under the awning in the aft of the vessel. The engine, which is of the Hindley type, and of 2 h.p. nominal, runs at 230 revolutions. The dynamo has an output of 25 amperes at 50 volts pressure. The lamps have protectors and guards similar to those on the "Glen Rosa." On these steamers the engine and dynamos are placed in a small cabin on the deck, with the exception of in the case of the "Cardinal Wolsey," where they are placed in the main engine-room, and steam is in every instance supplied from the main boilers. The dynamos are driven from the small engines by belting. The Victoria Association intends to light by electricity several other steamers. We are informed that the electric lighting of that portion of the vessels under the awnings has been particularly considered as a great boon by passengers, that those persons who formerly did not care for travelling at night by water, now that the electric light is installed take advantage of the company's steamers, and that no breakdown has hitherto taken place.

ADOPTION OF THE DUBLIN ELECTRIC LIGHTING SCHEME.

The question of the electric lighting of Dublin by the Corporation was agreed to at the monthly meeting of the Municipal Council, held at the City Hall, Dublin, on Monday last, the Right Hon. the Lord Mayor of Dublin, M.P., presiding.

Mr. ROBINSON, C.E., chairman of the special committee on electric lighting, moved the adoption of a report (nearly 40 pages) by that committee recommending that application be made for sanction to the borrowing of £50,000 to carry the scheme into effect, and also that the committee be empowered to acquire a site other than Islandbridge. The report contained an extended account of the proceedings of the committee, commencing with a resolution of the Council of October 22 last directing that necessary steps be taken to obtain a provisional order to authorise the Corporation to supply electricity for public or private purposes within the city. The report stated that the committee proposed to apply the system of illumination in the first instance in the lighting of the streets and premises from Nelson's Pillar to St. Stephen's Green, and through Dame-street, Parliament-street, Grattan Bridge, Mary-street, and Henry-street. Estimates made by the borough surveyor and Mr. Manville indicated that provision for 10,000 lights would suffice for the existing demand, and that a capital of £43,000 would provide the engines, boilers, dynamos, and all plant, including underground mains of size sufficient to meet the increasing demand, which might be anticipated as further improvements were made, and existing patent rights expired, cheapening the supply of electricity. This estimate the committee had raised to £50,000 to provide for build-ings and contingencies, but they looked forward to the exercise of careful economy in respect to any expenditure in connection with this subject. Very valuable information was received by the committee from other cities and towns, but before finally deciding on the plan and estimates, the committee named Aldermen Perry and Byrne, and Councillors J. L. Robinson, C.E., and Toole, accompanied by the town clerk and the borough surveyor, to visit some installations, in which success appeared to have been obtained. In the result further information of the first importance had been received, and the committee appended the report (Appendix A) of the results of this inspection. During the past few years electrical science has

been rapidly advancing, and several distinct systems of lighting were in successful operation. The committee were impressed with the responsibility of advising as to which should be adopted for Dublin. In connection with the proposal to utilise the water power at Island bridge, a system might be adopted by which electricity could be stored during the daytime. The report then proceeded: "The exact position of the controversy between the advocates of these systems will be best placed before the Council by the extracts from Major Marindin's report on the recent enquiry in London. He observes that of the scientific witnesses called as to the relative merits of the two systems, the great majority were in favour of the alternating-transformer system for large areas; and among his conclusions it will be noted that he reports 'that it must be admitted that the science of electric lighting has now reached the point at which a supply can be made which will be of very great benefit to the public, and that the power of obtaining this supply should be within the reach of all persons who may require it.' That there is a demand for the light has been shown not only by the answers received by Councillor Robinson in reply to an enquiry on the subject, but also by the evidence brought forward by the Alliance Gas Company at the recent enquiry in Dublin. The question of the relative cost of gas light and electric light is affected by the necessity for renewal of the incandescent lamps, which are at present expensive patents; but, even including these renewals, the Electric Lighting Committee of the Leeds Corporation consider the cost equal to that of gas at 3s. 5d. per 1,000 feet. This is exclusive of the greater advantages attendant on lighting by electricity—such as greater illuminating power, freedom from deleterious atmosphere, cleanliness, and the avoiding of injury to gilding, to soft goods, and to various mercantile wares, at present unavoidable in places where gas is used. Your committee now beg to recommend that application be made to the Local Government Board for sanction to the borrowing of £50,000 to carry into effect the scheme proposed, and also beg to recommend that your committee be empowered to acquire a site other than Islandbridge in the event of one being found to be more suitable."

Mr. ROBINSON then urged the importance and value of electric lighting, and pointed out the advantage it would be to have the station down at Sir John Rogerson's quay, for they would there have coal at their doors, and they could avail themselves of the new engineering system by which sewage was disposed of by the aid of electricity. They would be saved the enormous expense of sending out the sewage of Dublin to the Nose of Howth.

Alderman FLANAGAN seconded the adoption of the report.

Mr. MILEY spoke in support of the report.

Mr. H. GILL said that there were a certain number of gentlemen who desired to carry this system of electric lighting, though it was pretty certain it would involve this city in loss. One of the most recently-started electric lighting company's shares were being sold at a heavy discount. In justice to his constituents in this city he should protest against the adoption of this report, for he desired to place this protest on record, as he considered it probable they would in a few years realise that what he now said was true. Mr. Robinson said that the cost of this project would be about £43,000, but that, at all events, he would be safe in putting the expenditure at £50,000. The cost of the Varty scheme was estimated by the most eminent engineers, whose estimate was only about one-fourth of the actual cost. Mr. Robinson said that the electric lighting system at Eastbourne was paying 11 per cent.

Mr. ROBINSON: No; Rochester.

Mr. GILL read the following passage in the report in reference to electric lighting in Sheffield by the Sheffield Telephone Exchange and Electric Light Company: "The company's undertaking in Sheffield yields a dividend of 7½ per cent., and in addition a large reserve fund has been created, but the company carries on a large telephone exchange business, in addition to the electric light." Mr. Gill then said that that company might perhaps be able to pay 10 per cent. instead of 7½ per cent. but for the electric lighting which it carried on. He was opposed to the adoption of the report because he believed the system of electric lighting proposed would result in loss to the city.

Alderman DENNEHY, in opposing the adoption of the report, said they would have to deal with contractors and others, and it would be difficult to arrive at a close estimate of the cost of a proposal of this kind.

Mr. O'MEARA congratulated the committee on the valuable report presented, and which was in fact a treatise on electric lighting. In the appendices to the report the conclusions at which the committee had arrived were set forth, and the report and its recommendations were of such a character that he gave them his unqualified support.

Mr. J. B. HEALY said the proper lighting of the city of Dublin was a matter which was entitled to their best consideration. He did not think that the city of Dublin should be left as it was, while it was in their power to adopt a much more im-

proved system. With regard to the opinion of the people of Dublin on this question, they were in favour of electric lighting, and certainly they had no desire that they should have, as at present, to flounder on in the dark.

Alderman MEAGHER pointed out that if the Corporation did not undertake the electric lighting of Dublin, private companies were ready and anxious to step in and derive the profits to which the citizens were entitled. He could not understand why there was such apprehension on the part of those interested in the gas company, as there was ample room for the two systems in the city of Dublin. The gas company themselves sought powers to supply electric lighting, and still those interested in the company were opposed to the Corporation getting the same powers. In other cities the municipal authorities had taken these powers of electric lighting, and he did not see why Dublin should be deprived of the advantages of superior public lighting enjoyed in other cities.

Alderman BYRNE supported the report, and pointed out that in Leeds and other cities where gas was a charge of 1s. 10d. per 1,000ft. they had decided on utilising the electric light. The municipal authorities were not all fools.

Mr. DOHERTY said although electric lighting might cost more the benefit to the citizen would compensate for the extra outlay.

Alderman PERRY supported the report, and stated that he had the authority of Mr. Richard Gunn to say that if the Corporation got the proposed power he would have the whole of the Gaiety Theatre lighted by electricity. If Dublin did not take such forward steps as other cities were doing, it would be left in its present backward position.

Mr. ROBERT SEXTON said no doubt electric lighting would be the light of the future, and should be in the hands of the Corporation, but the question was, were they at present in a position to undertake it, and was electric lighting yet only an experiment? He thought before they embarked in the undertaking, they ought to have further information as to the cost, which might be enormous. The lighting of Dublin at present was certainly scandalous, and some better system should be adopted.

The LORD MAYOR said electric lighting had now passed out of the category of experimental questions. They were all aware of this, after what had happened at the enquiry in London, where several companies competed in offering to supply the city with electric lighting. If the Corporation of Dublin waited in taking steps in this matter the ground would be occupied by somebody else. But the principle was adopted by the Council last October, and they were simply carrying out the instructions the Corporation had in view. They had applied for a license, and if they did not proceed in the matter the Board of Trade would have a good excuse to give the gas company a license to provide electric lighting, which would add a monopoly to the monopoly of gas lighting they now enjoyed. As regards the expense, he did not think it was a matter for exaggeration. Of course there would be a risk, but not a great one, and there might be a loss for a time, but the Corporation were now in a good position to procure the necessary money. The repayment of a loan of £50,000, interest and principal, would mean a penny in the pound, while the gas bill amounts to five-pence in the pound. The old saying, "Nothing venture, nothing win," applied particularly in this instance. He believed the ratepayers of Dublin were quite willing to run the risk, and he believed they would be well advised in doing so, if they only had the two objects in view—that of cheapening the gas and increasing the facilities of the undertaking of the gas works by the Corporation.

The motion was then adopted by 38 to 3 votes, the minority consisting of Sir George Owens, Alderman Dennehy, and Mr. Gill.

CITY NOTES.

Direct Spanish Telegraph Company.—The estimated receipts for August were £1,624, against £1,643.

West Coast of America Telegraph Company.—The receipts for the month of August amounted to £4,850.

Great Northern Telegraph Company.—The receipts for August were £24,000, making from the 1st of January a total of £178,200.

Eastern Telegraph Company.—This Company's traffic receipts for August amounted to £52,012, as against £43,703 in the corresponding period of 1888.

Western and Brazilian Company.—This Company's receipts, after deducting the "fifth" payable to the London Platino-Brazilian Company, were £3,622.

Cuba Submarine Telegraph Company.—The traffic receipts for August were £2,700, against £2,860. The receipts for May, estimated at £3,500, realised £3,513.

Eastern Extension Telegraph Company, Limited.—This Company's traffic receipts for the month of August were £39,469, as against £38,103 for the same period of 1888.

West India and Panama Telegraph Company.—The receipts for the half-month ended August 31 were £2,118, against £2,520. The May receipts, estimated at £6,219, realised £6,205.

PROVISIONAL PATENTS, 1889.

AUGUST 26.

13444. **Improvements in dynamo machines and the application thereof for regulating electric arc lamps, and other purposes.** Franz Reisinger and Wilhelm Wenzel, 28, Southampton-buildings, London.

AUGUST 27.

13459. **Improvements in the construction of electric accumulators.** George Downing, 8, Quality-court, Chancery-lane. (Johann Franz Weyde and Ferdinand Clas, Austria, and Jules Elsner, France).

13480. **Apparatus for charging storage batteries, and other purposes.** William Prescott Kookogey, 62, St. Vincent-street, Glasgow. (Complete specification.)

13541. **Improvements in electric wire and pole connectors.** Christen Rees Bonne, 41, Eastcheap, London. (Messrs. Mix and Genest, Limited, Berlin.) (Complete specification.)

13557. **Improvements in or connected with holders or sockets for incandescent electric lamps.** James Yate Johnson, 47, Lincoln's-inn-fields, Middlesex. (James Walter Collier, United States.) (Complete specification.)

AUGUST 28.

13580. **An electric body belt.** George Henry Redfern, Porter-street, Staveley, near Chesterfield, Derbyshire.

AUGUST 29.

13636. **Improvements in the manufacture of indigo by the application of electricity.** Frank Hughes, 76, Chancery-lane, London. (Æneas John McDonald, East Indies.) (Complete specification.)

13640. **Improvements in electric switches.** Walter Thompson, 17 and 18, Southampton-buildings, London.

13658. **Improvements in automatic transmitters for telegraphic purposes.** Hugo Lubliner, 45, Southampton-buildings, London.

AUGUST 30.

13675. **Improvements in the arrangements and apparatus for electrically lighting railway trains.** William Edward Langdon, Midland Railway, Derby.

AUGUST 31.

13778. **Improvements in electric bells, and in apparatus for use in connection therewith.** Charles Henry Martin, 11, Corporation-road, Middlesbrough.

SPECIFICATIONS PUBLISHED.

1888.

11529. **Indicators for electric light switches.** Towle and Langdon. 6d.

11809. **Measuring electric potential, &c.** Maurice and Others. 11d.

12376. **Electric accumulators, &c.** Wise (Van Gestel). 8d.

13473. **Electric launches.** Sherrin and Sherrin. 8d.

14426. **Electric switches.** Snell. 6d.

17978. **Telegraphing.** Farquharson. 6d.

1889.

2375. **Telephones.** Wilkins. 8d.

5014. **Electric railways.** Van Depoele. 8d.

11044. **Storage batteries.** Thompson (Alexander). 6d.

11067. **Insulation for electric conductors.** Snedeker. 4d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.	Name	Paid.	Price Wednes- day
12 Feb. 1/2	Anglo-American Brush E.L.	—	—
12 Feb. 2/0	— fully paid ..	—	—
14 Nov. 0/4½	Con Telephone & Main ...	1	3½
27 July 10/0	India Rubber, G. P. & Tel.	10	19½
.....	House-to-House	4½	4½
.....	Metropn Electric Supply	—	2½
.....	London Electric Supply ...	5	3½
.....	Swan United	3½	4½
12 July 12/0	Telegraph Construction ...	12	43½
2 July 6/0	— 6%, 1889	100	105
.....	National Telephone	5	6½

Brazilian Submarine Telegraph Company.—The receipts of this Company for the week ended August 30 amounted to £4,877.

Companies of the Month.—The following electrical companies have been registered during the past month:

Alcoy and Guadia Railway and Harbour, £100 shares	£525,000
Brush Electrical Engineering Co npany, £2 and £3 shares .	750,000
Chili Telephone Company, £5 shares	250,000
Fowler-Waring Cable Company, £5 shares	200,000
Johannesburg Electricity Supply Company, £1 shares	250,000

NOTES.

Stoke.—The Stoke-on-Trent Town Council opposes the introduction of electric light.

A City Lighted.—Moscow is to be lighted with a 500-light plant. Moscow, Oreg., U.S.

The Shockeries.—The electrical exhibition at Birmingham has been dubbed the "Shockeries."

Jamaica.—A scheme is on hand for lighting the city of Kingstown, Jamaica, by electric light.

Melbourne.—The electric tramway of Melbourne will shortly be opened in part for public running.

Ilkeston.—The Town Council of Ilkeston oppose the Midland House-to-House Company's application.

Lighting Coal Mines.—Two pits at Morton, belonging to the Clay Cross Company, are being lighted by electricity.

Cardiff.—Several companies are competing for the right of lighting this town. The matter is in the hands of the committee.

Washington.—It is proposed to light Washington by electricity from power derived from the Great Falls of the Upper Potomac.

Electric Lamp-Posts.—Messrs. John Spencer and Co., Wednesbury, informs us that wrought-iron tubes have been reduced $2\frac{1}{2}$ per cent.

Park Lighting.—It is proposed to light the Alfred Park, Allahabad, by 45 lamps of 50 c.p. The work is in the hands of Messrs. Siemens's representative.

Zurich.—The contract for the supply of electric light plant for the town of Zurich has been definitely awarded to the Oerlikon Works at the amount of 1,327,884f.

Southend.—A scheme brought before the Southend Local Board by Mr. Hemmann for lighting the cliffs by electricity has been referred to the Roads Committee.

Oldham.—Messrs. S. Charlesworth and Co., of Oldham, will henceforth carry on their business as electrical engineers under the name of Messrs. Charlesworth, Hall, and Co.

Huddersfield.—The Corporation of Huddersfield have instructed their clerk to take the necessary steps to secure for themselves a provisional order to supply light within the borough.

Aberdeen.—A special meeting of the Aberdeen Town Council will be held shortly to consider the desirability of applying for a provisional order to authorise the Council to supply electric light.

Norwich.—The Electric Lighting Committee of the Norwich Town Council are intending to take the advice of experts upon the possibility of obtaining power for electric lighting from the falls at New Mills.

Telephones in Scotland.—The National Telephone Company have commenced to erect a trunk wire between Dundee and Glasgow for the purpose of establishing telephonic communication between these cities.

Progress in Berlin.—The amount paid in royalties to the town of Berlin by the central electric stations equal to £167 in 1885; £1,366 in 1886; £2,952 in 1887; and £4,739 in 1889. The royalties are 10 per cent. of the gross receipts.

Paris Conduits.—Mr. Crompton is testing his air-insulated mains on the system described in another note, in a 10in. iron pipe for use in the underground mains of Paris. The authorities in Paris stipulate for iron pipes to be used in all their work.

Burton.—The Gas Committee of the Burton-on-Trent Town Council have received the manager's report as to the lighting of a portion of the borough by electricity. A statutory meeting of the Council will be held to consider the whole question of electric lighting.

Vevey Electric Railway.—The electric railway between Vevey and Montreux carried during the vine festival at Vevey, during the week ending 10th August, a total of 55,786 passengers, taking an income of 14,478f. This was equal to an average of £87 per day.

The Electro Harmonic Society.—We are requested by the honorary secretary to inform members that should their communications to him not receive the usual prompt reply, it will be in consequence of his absence from home during the meeting of the British Association.

Train Lighting.—The Pullman Palace Car Company have just shipped 22 sleeper-cars to an American railway company, all of which were wired for electric lighting. Electrical Accumulator Company's storage cells will be employed. These cars had formerly been lighted by the Pintsch gas system.

Cable Repaired.—The Anglo-American Telegraph Company's cable between Brest, France, and St. Pierre Miquelon, laid in 1869 and broken in deep water on the 17th of July last, was successfully repaired on the 5th inst. by the company's steamer "Minia," Captain Trott, commander, and is now working well.

Conference on Mining.—The conference on mining and metallurgy in connection with the Paris Exhibition began its work on Wednesday. The following subjects are to be discussed: Safety lamps, the use of electricity in mines, blasting materials, ventilation, communication, and transmission of motive power in mines.

Adjustable Transmitter.—In the usual form of telephone, the transmitter is fixed, making it awkward in speaking for either short or tall persons. Mr. J. Cuthbert Goulding, of Cardiff, has introduced a form of transmitter which obviates this disadvantage, being made adjustable to height by means of a swivel-joint arrangement.

Telephonic.—The Western Counties and South Wales Telephone Company have sent us their list of 288 pages, comprising subscribers connected from Southampton to Plymouth, and from Swansea to Shrewsbury. The work contains a map of their trunk lines, and is evidence of the unceasing activity of this enterprising company.

Machine Tools.—The Britannia Company, of Chelmsford, send us their last list of machine tools, including screwing-machines, boring, drilling, and surfacing machines for large work, and electrical engineers' drills, such as will be constantly and increasingly required where work is extending or new machines are being introduced.

Rotherham.—At the last meeting of the Rotherham Town Council notices were read from the House-to-House Electric Company, Limited, and the Electric Construction and Maintenance Company, Limited, of their intention to apply to the Board of Trade for a provisional order authorising them to supply electricity in the borough.

Four-Piston Engine.—A reversible rotary engine, having four pistons, and developing power with great economy in fuel, is being built by Jos. S. Kiehl, of Chicago. It is designed for train lighting service and can be coupled direct to the shaft of the dynamo or in the ordinary way by belting. Automatic regulation admits of high or slow speeds.

Uruguay.—The Municipality of Monte Video has recently granted several concessions for new lines of tramways. Particulars of these could be obtained of the Consulate of Uruguay. A review of the recent progress of this state can be seen in a general description, with data and illustrations, published by Rockliff Bros., 44, Castle-street, Liverpool.

Continuous Rails.—Prof. Elihu Thomson is said to be strongly advocating the use of a portable electric welder to run along the railway lines and weld together the iron or steel rails in continuous lengths. Joints will be left every 100ft. only to allow for expansion. It is expected by this means the jolting of the railway carriages would be greatly decreased.

Ceylon.—We are glad to see that attempts are being made to introduce the electric light into our colonial dependency of Ceylon. There is a wide field in this possession as yet little explored. Mr. Percy Sellon has, we hear, recently paid a visit to this colony, and thinks well of the openings for business in electrical plant. We hope soon to hear of large plant being sent out.

Prepayment for Light.—It is interesting to note that the system of supply of fixings by the gas companies and prepayment system for gas on the penny-in-the-box system is working very satisfactorily at Ramsgate. The cost per house is less than £4, made up by an increase in the rate from 3s. 2d. to 3s. 9d. per 1,000. Nearly 200 applications were received at once, and the whole scheme has given satisfaction. The amounts are collected weekly from the boxes.

Telephones from Lancashire to London.—At the monthly meeting of the Prestbury (Cheshire) Highway Board, an application was considered from the National Telephone Company for permission to erect pole-carrying wires along the roads towards Congleton, from the Macclesfield boundary. The requisite permission was granted. This will now cover the space which will bring all Lancashire and Cheshire in direct communication with the metropolis.

French Telephones.—The dispute between the French Telephone Company and the Government is likely to be brought before the courts, but it is not likely that the company will receive much public support in business circles, for the result seems to be a considerable decrease in the rates. Already the subscriptions for telephones have been reduced from £22 to £16 for Paris; and from £16 to £12, or even in some places £8, in the provinces. Municipal control will evidently tend to public benefit.

Telegraph Cut-Off.—The Hatch lock, invented by A. A. Hatch, of Kansas City, mentioned in the *Electrical World*, is a device to be used in telegraphy, by means of which all connections with a telegraph wire can be cut off at all intermediate points between the sender and the receiver. The patent is equally applicable to telegraph wires and their connections. The invention is said to have been in use on the St. Louis, Fort Scott, and Memphis Railway for some time, and has worked successfully.

Storage Stations.—At the recent meeting of the German Society of Engineers, at Karlsruhe, Herr Heinbeck stated, in an interesting paper, that practical results show that the working of a central station is far more economical and certain with accumulators than on the direct supply system. He states that 15 to 20 per cent. greater economy results from the use of a storage system for the same output.

New Works in Newcastle.—Large and commodious premises are being constructed at Heaton, Newcastle-on-Tyne, for Hon. C. A. Parsons and Co., whose works are now at Park-road, Gateshead. The plant from the present works will be removed to Heaton, and the new works when finished will cover some four to five acres of ground. They will be arranged for the manufacture of electrical machinery in connection with the Parsons high-speed turbo-generator, and will give employment to large numbers of persons.

Rome.—It is announced that the international electrical society, recently organised at Vienna, has received a contract for a central station at Rome to light an important part of this city. Power will be obtained from the waterfalls at Tivoli, of which 2,000 h.p. will be used to drive high-pressure alternate-current machines, which will be transmitted to Rome along a distance of nineteen miles, and connected to the central station already existing. The station at Tivoli will also supply 1,700 h.p. for other lighting, and for transmission of power. The plant will be on the Zipernowski-Deri-Blathy system.

Salt Lake City.—An electric railway was opened at Salt Lake City, Utah, on August 16 with great ceremony. The Mormon city is now, so far as outward appearances goes at any rate, quite a little paradise below, with broad streets shaded with trees, lovely buildings, fertile fields where once were only salt marshes, and now the good fathers have introduced the electric motor to run their cars. The material progress made by a band of men in these veritable wilds may well make us reflect what beauties London might possess if the energies of her sons were also bent on developing them to the utmost.

Newcastle.—Intimation has been given to the Newcastle and District Electric Lighting Company, Limited, that the terms of their license have now been practically settled with the Board of Trade, and therefore the company expects to be in a position to commence the laying of the main cables almost immediately. Great inconvenience has been suffered by the company through so long a delay in procuring the license, without which it was unable to lay its cables. The machinery and plant, however, are now well forward; and the company intends to push the work vigorously, so as to be able to supply current to its customers before the end of next month.

Harold P. Brown's Letters.—A sensation has been caused in New York by the publication in the *New York Sun* of letters purporting to be between Harold P. Brown and others. Mr. Brown is exhibited as intimating to Edison that he wants 5,000dols. to "show the lack of efficiency of Westinghouse dynamos and head off investors." He did not get it, and turned to the Thomson-Houston, to whom it appears that he hinted that if he did not get Westinghouse dynamos he might use theirs, saying that he had "withstood tremendous pressure and tempting offers to use other machines." In short, Mr. Brown shines in brilliant light of a person extremely "on the make." Are the letters genuine? If so, Mr. Brown himself is genuinely "done brown."

Electric Light and Cathedrals.—The wisdom of the Benchers of the Temple in steadily refusing to admit gas within the sacred precincts of their ancient shrine has been more than justified, says the *Daily Telegraph* in a recent note, by the results of gas upon the clerestory of Gloucester Cathedral, where after centuries of existence the stone had preserved its colour; but since the placing of the gas jets below the clerestory there has been a steady discolouration. It is to be hoped that the Dean and Chapter of St. Paul's will secure electric lighting for the dome now that the spandrels are being filled with new subjects. The electric light in the Temple Church has proved a great success; and shows up the rich stone and coloured marbles with great effect.

A Central Station for Bombay.—The committee appointed by the Corporation to consider the question of lighting the city has, it is stated, decided that the existing contract with the Bombay Gas Company, which has now but a year to run, shall be continued for a further period of three years, subject to certain modifications. An area is to be reserved for the introduction on a considerable scale of electric lighting. The district which will be appropriated for this innovation will include some of the principal streets up to the new municipal offices, and the adjacent open spaces which were a few years since lighted by electricity. It is believed to be the intention to make the concession for the lighting of this area depend upon the results of a public tender.

Helsby Cables.—It is not often we are called upon to acknowledge the receipt and to report upon a much handsomer collection of commercial samples than that forwarded to us by the Telegraph Manufacturing Company, of Helsby, near Warrington, and 11, Queen Victoria-street, E.C., in a neat red and gold lettered case, folding up in the form of a book for the library shelf, labelled "Electric Light Cables." We have a complete set of conductors—pure and vulcanised, double rubber coated, and served with braid—ranging up from single strand No. 20 to 19-12 cable for electric lighting purposes. The cards are fastened with bands of elastic only for ready reference, and altogether supply a sample case of most neat and convenient design. We commend this "volume" to our readers; no technical library should be without it.

Weems Electric Railway.—The size of the train on the Weems electric railway, which has recently been tested, it is stated, to a speed of two to three miles a minute, is $2\frac{1}{2}$ ft. square by about 20 ft. long, pointed at both ends. It is stated that leases of farm lands in Garden City, Long Island, have been secured for five years, on which it is proposed to build two circular tracks, one of five miles circumference for automatic tests, and an inner circuit of four miles for passenger trains, together with a generating plant of 250 h.p. It is intended to start the construction of these roads by September 15. The equipment has already been contracted for. The company estimates that it will be necessary to make an outlay of from 80,000 to 100,000 dols. The Garden City scheme is said to be preliminary to an enterprise embracing the formation of a syndicate for building a railway from New York to Philadelphia and subsequently to Chicago, a distance of some 2,000 miles, which it is confidently expected will be traversed at the speed of 300 to 400 miles an hour.

Artistic Fittings.—The demand for artistic fittings in Berlin, according to a recent note in *Kuhlows Gazette*, seems to be now very large, and although the tendency to large and cheap fittings is deplored, there seems to be a

very important trade springing up. The Berlin manufacturers not only supply the German requirements, but also those of Austria, Holland, Belgium, Sweden, and Danubian principalities. The demand from those parts mostly includes articles in bronze and wrought iron, combined with copper or brass. Phosphor bronze is largely used, and still more modern at present is the gold bronze, used for roccoco articles, which are at present in fashion. They are ornamented with parts in majolica or porcelain, and it is sought to produce coronas, lustres, and all other articles connected with lighting, whether for gas or electric light, richly mounted and so that they will make a pleasing impression on the eye. The numerous new buildings which are being erected in Berlin, and the great attention which shopkeepers devote to the ornamentation of their show-windows promote the activity in the lighting appliances branch, which cannot complain of a want of employment.

Increase of Tractive Power by Electricity.—The electric traction increaser for increasing the tractive power of locomotive engines, invented by Elias E. Ries, of Baltimore, has just been tested, according to the *American Engineering News*, with very satisfactory results, on the Philadelphia and Reading Railroad. The trials were made on the Frackville grade, 185 feet per mile. The apparatus consists of a small dynamo and engine mounted up on the locomotive and furnishing an electric current, which is passed from the forward to the rear driving-wheels, through that portion of the track rails lying between them, causing an increased friction between the wheels and the rails, which is claimed to be far superior to that obtained by sanding the tracks. With the dynamo running and a train of 45 cars attached to the locomotive, the ascent was made in 28 minutes, while without the current a trip over the same ground, with the same train behind, required 55 minutes. The current used is low tension and the increased traction obtained is under complete control by the engineer. The method, as described above, seems to us to be worthy of serious consideration by railway engineers, especially for those lines where severe gradients are a feature of the line. We hope tests will be made of its usefulness in this country.

Turning Down Electric Lights.—Household users of incandescent lamps, present or prospective, have one question they often ask, Can the electric light be turned up or down? The answer is, it can, by a special arrangement of resistances, for which extra must be paid. It seems that this necessity is sometimes a real one, for instance, for sick-rooms, but it is rarely carried out. This is because in electric lighting there is no saving in turning the light down, at any rate for a single lamp, because the current is merely wasted in heat elsewhere. In theatres, however, where many lamps are employed, the lamps are often shunted into series to reduce the current. In the case of a single lamp or two this is not so easy to arrange. Where such a thing is necessary, it seems to us that it would be preferable not to diminish the heat of the lamp by generating it in part elsewhere, but to diminish the light of the lamp itself. This could be easily done by the arrangement of a translucent or opaque shade of two or more shades, which could be turned round to shade the lamp as desired. This would be perfectly easy, and would be far preferable, in our opinion, in most cases than the semi-scientific talk by the company's electrician about providing an accessory resistance, which, if carried out, would be an extra expense, and also, in most cases, more or less a source of danger.

Induction Experiments by Prof. Thomson.—

Some very remarkable and interesting experiments upon the nature of induction have been shown at the Gallery of Liberal Arts, at the Paris Exhibition, and an illustrated account is given by M. Hospitalier in *La Nature*. These experiments consisted in suspending a ring of copper in air without contact some 7in. above a coil in which an alternating current was passing; of showing objects which persistently refuse to stay in their places when the current is turned on; of balls of metal suspended in water and rapidly revolving without apparent means; and last, and most extraordinary in its effect, a small coil of insulated wire, to which is attached an incandescent lamp, put into a vessel of water, and when the current is turned on this rises in the water till the repulsive effect is balanced by the hydrostatic effect, at the same time lighting the lamp under the water by the inductive action in the coil. The reason of the repulsion acting in this extraordinary way against gravitation is that the induced currents oppose the variation of force and cause the induced currents to lag a quarter period behind. The sum of the attractions is then less than the sum of the repulsions, and if sufficient the difference will hold the ring suspended in space.

Type Setting by Electric Motor.—

The publishers of the *Chicago Evening Journal* have recently installed a Thomson-Houston motor for running a Thorne type-setting machine. This consists principally of two iron cylinders about 18in. in diameter and 30in. in length, mounted vertically one above the other on the same axis. A series of vertical grooves runs the entire length of cylinders, and as the upper cylinder revolves with an intermittent motion, the grooves in it are brought directly over those in the lower cylinder. A line of used type, as it comes from the "forme," is slipped into any groove in the upper cylinder, and this, as it revolves, drops each separate type into its respective groove in the lower cylinder, the operation being effected by a system of notches cut on the side of each type, and which notches correspond to a ward placed at the upper end of the grooves on the lower cylinder. The operator sits in front of a large keyboard somewhat resembling a typewriter, and by depressing a key causes the lowest type in the corresponding groove of the lower or "setting" cylinder to drop outward on a rapidly revolving disc which carries it to an opening in a sort of guard rail surrounding the disc, and delivers it upon a moving belt, on which it is carried to a lifter which raises it into a long setting-stick directly in front of the operator. This setting-stick terminates in a justifying-stick at the operator's left, and a second operator does the work of justifying. A section of the composed type is drawn to the mouth of the justifying-stick, and is justified with spaces taken from a case containing channels for the different spaces and the hyphen, the lowest of which are partially pushed out by ejectors worked with a treadle. It is claimed that the machine will distribute and set type at the rate of 6,000 ems per hour, two girls and a boy doing the work of six men. It will be seen that this machine, unlike the Linotype, sets ordinary type which has afterwards to be justified or spaced. A Thorne machine is working at the Edison stand at the Paris Exhibition. It bids fair to be a really useful invention.

The Five-Wire System.—The following abstract of a paper by Dr. Kreiger, of Königsberg, is given in the *Electrical World*, from which it appears that the five-wire system is to be introduced into that city: We have no

sense affording a direct perception of electricity. Still, although we are unable to see the play of the phenomena, the practical applications increase daily. A central station is about to be erected in Königsberg for supplying electric light and power, and the manner of doing this is full of interest. Imagine a raised tank, from which water is led through mains to a turbine, and you have an image of the electric current. The height of the water corresponds to the electric pressure above the earth, which is obtained by dynamos. In dealing with large quantities of electricity we must provide a special return lead, similarly with water, by means of a water discharge. The larger the current of electricity the larger the wires, which, with a large number of lamps, become considerable. If we desire to run a double number of turbines with the same quantity of water, we must raise it to twice the height and place one turbine above another. In the same way the number of lamps is increased without more copper by doubling the pressure and connecting two lamps in series. To this end a third lead is placed between the two usual ones, the lamps being equally distributed on both sides, in which case each lamp will receive sufficient current. Returning to the turbines, and supposing the number of upper ones is smaller than the lower, while each requires the same quantity of water, then the water flowing from the upper stage will not suffice for the lower, and to obtain normal work a special water-pipe must bring to the lower ones sufficient to make up any deficiency; so with the lamps. If the middle lead returns to the station it can either bring or convey away, if the two divisions are unequally burdened, sufficient electricity to supply the surplus lamps. In a large supply this difference will not exceed one-third, so that the extra lead only requires one-third the section of the others. Such a system is called a three-wire one. Now suppose the lamps fixed serially in four branches and we have the five-lead system, such as is about to be used in Königsberg, and which requires only about one-tenth the weight of copper as compared with the two leads.

Reporting Progress.—Progress is going on so rapidly in some districts that it is really almost difficult for electrical men engrossed each in their own work to keep pace with the facts, if they have not had special occasion or opportunity to inspect the work. We have reported progress on several of the central station undertakings, and this week we paid a visit to Mr. Crompton's works at Kensington. What will be thought of the statement that here they are potentially, if not at the present moment actually, in the position to supply some 300,000 incandescent lights in the district lying between Kensington Park to Notting Hill on one side, including by Queen's Gate, Exhibition-road, Cromwell-road, to Brompton and Sloane-square. The mains are laid, ramifying in all directions, in culverts or conduits; two new large stations are practically finished, one in extension of the old Kensington Court station, where a handsome building is approaching completion, alongside which Mr. Crompton is building a fine house for himself, in which he will reside shortly, and from which he will superintend operations. The other station is finished and working, though only a small part of the machinery is yet placed in position. This new station is situated at the opposite end of the district to Kensington Court station, being at Chapell-place, Knightsbridge, and the two stations will serve on to the same service mains. There are 10,000 lights at present at work; 35,000 lights will be lighted in

three months from now, nearly all of which are ready wired. Several subsidiary battery stations are constructed, and more will be put down. The generating stations, with the secondary stations, will eventually be in the position of being able to supply current sufficient for a total number wired, as mentioned above, of 300,000 lamps, though it is hardly expected, even of this, one of the richest districts in London, that so many as this will be required for at least many years. The plant in the new station will be the same as that supplied by Messrs. Crompton for the Vienna installation, consisting of Babcock-Wilcox boilers, Willans engines, and Crompton dynamos, on the direct supply system, with accumulators as reserve. The present plant is to be six engines of 250 h.p., with boilers for 2,000 h.p., and battery power sufficient, if necessary, to give out at one time 5,000 h.p. The dynamos are wound for about 250 volts, and are of 180 h.p. each. The service will be maintained at 220 volts in the mains. The mains are being laid on the three-wire system in underground culverts, the main culvert leading out of the station being 7ft. high. The smaller culverts range about 2ft. deep, but vary according to position. The system used is that of air insulation, with occasional contacts. The conductors are thick solid strips of copper in one, two, or three strips each, three sets in each culvert. Iron boxes are provided at certain distances, and the strips are strained tight by means of screw-jacks, and firmly bolted to the iron framework of the box, through very strong glass insulators, furrowed to prevent surface-leaking, and backed with indiarubber washers. The company have a large map, threaded with different-coloured threads, hanging in the office to indicate with exactitude the position, number, and capacity of the main cables and feeders. Arrangements are made for the gradual increase of the plant as demand increases, but the buildings are now complete for the full supply.

Electric Tabulating System.—Mr. H. Hollerith has sent us a description, originally appearing in the *American School of Mines Quarterly* (No. 3, Vol. X), of his electric tabulating system, which we have already alluded to, and which seems to be destined to effect a wonderful revolution in the methods of tabulating the vital and other statistics relating to a general census. The importance of the subject, not only from the point of view of information, but from that of mere expenditure, can be gauged when it is stated that the American Congress fixed the cost of the next census to be taken on June 30, 1890, exclusive of printing, at 6,400,000dols. A census may be compared, says Mr. Hollerith, to an instantaneous photograph of the whole country and the process of tabulating to the development process, to bring out first the main features and afterwards the half tints. If the country is to spend 3,000,000dols. on exposure, the picture ought to be properly developed. The statistics capable of being developed are the replies as to race, colour, sex, age, relationship, conjugal condition, occupation, and time employed; whether sick and temporarily disabled on day of census; blind or otherwise permanently disabled; cannot read and write; place of birth of self, and of father and mother; also deaths during previous year. Such an enumeration of this would correspond to a fully timed exposure of the photographic plate. It is not enough to simply enumerate the additions of these items, and yet much statistical information of the combinations has had to be left hitherto for want of funds. To know the number of single or married is of great value,

but it would be of more value to have this information in combination with age, sex, occupation, etc. Again, we have information regarding age and occupation. If the living population were tabulated by combinations of age and occupation, and likewise the deaths by ages and occupations, we should then have data from which reliable inferences might be drawn regarding the effects of various occupations upon length of life, and it might be possible to construct life tables for the various occupations, which would be of material use to the insurance offices. They would also point out needed reforms in sanitary or other conditions. This is a field of investigation which as yet is almost entirely unexplored, and is one which almost before any other than that of defence, belongs to the work of the State. To obtain these data quickly and reliably is the object of Mr. Hollerith's machine. In the usual method, if the answers were written on a broad strip of paper half an inch apart, it would take a length of 500 miles to contain the answers of the approaching American census. Each of these items would have to be gone over by the eye again and again, and ticked off by the persons tabulating. Or if cards were used 450 tons would be required, and if a single card became displaced it would cause almost endless confusion. Instead of this method Mr. Hollerith proposes a combined mechanical and electrical machine, which, by means of cards first punched with holes corresponding to the returns, can have any combination of electrical contacts connected by the falling of metallic pins into mercury cups through the holes on the cards, and thus moving any desired number of dial counters step by step by means of electromagnets. The details of this machine, the cards, and the punches Mr. Hollerith has very ingeniously worked out. The record cards (size about 3in. wide by 5½in. long) have a carefully arranged set of divisions of quarter inch squares, each square having a special meaning or number assigned to it, which of course can vary according to the statistics required. The divisions would correspond to sex, married or single, illiterate, etc. But details of specification would be indicated by a combination of two or more holes. These would be punched by a special machine having movable punches, and several cards could be punched at one operation. The district is indicated by a certain combination, and on a card being misplaced it is only necessary to run wires through the bundle of cards to detect a misplaced card at once, this alone saving endless confusion and research. In tabulating, a series of dials like small square clocks are arranged on shelves on a table, each one registering to 10,000, and all being movable and interchangeable, and arranged to make their own electric contacts on being pushed into their places, so that manipulation is simple and easy. Their electromagnets are connected to a battery and to the mercury cup of a tabulating plate. The cards are slipped one after the other rapidly into a slot, a press with spring points is brought down, contacts are made through the punched holes only, and the whole of the details of one card is registered at one operation. By a suitable system of relays any possible combination can be taken. For the two, at present, most important features of a census—time and accuracy—the system presents great advantages, but the greatest will be the possibility of a thorough compilation and tabulation of all details. The introduction of this system can hardly fail to be of immense utility to statisticians and Government departments in many branches; and Mr. Hollerith's work will probably be found to have been one great factor in the knowledge of conditions of life and the subsequent advancement of humanity.

THE BRITISH ASSOCIATION AT NEWCASTLE.

PRESIDENTIAL ADDRESS.

The fifty-ninth annual meeting of the British Association opened on Wednesday, at Newcastle-on-Tyne. The town is crowded with distinguished visitors, and, from the tickets issued, it is expected that this year's meeting will be a large and thoroughly successful one. The inaugural address took place in a large hall, holding 3,000 people, which was filled with a brilliant audience. Sir Frederick Bramwell, F.R.S., the retiring president, took the chair, and gracefully introduced his successor, Prof. Flower, F.R.S., to whose work he said it would be supererogation to mention—first, in the Crimean War, afterwards in connection with the Museum of the Royal College of Surgeons, and later in the office he now holds, of Director of the Natural History Branch of the British Museum at South Kensington—work which had made him world-renowned. Sir Frederick Bramwell then vacated the chair, which was taken by the President, Prof. W. H. Flower, C.B., LL.D., F.R.S., Pres. Z.S., etc., who was received with loud cheers.

The President then delivered his address, in which he took for a subject the importance of public museums, and from which we take the following extracts:

The first recorded institution which bore the name of museum, or temple or haunt of the Muses, was that founded by Ptolemy Soter, at Alexandria, about 300 B.C.; but this was not a museum in our sense of the word, but rather, in accordance with its etymology, a place appropriated to the cultivation of learning, or which was frequented by a society or academy of learned men devoting themselves to philosophical studies and the improvement of knowledge.

All the earliest collections, comparable to what we call museums, were formed by and maintained at the expense of private individuals; sometimes physicians, whose studies naturally led them to a taste for biological science; often great merchant princes, whose trading connections afforded opportunities for bringing together things that were considered curious from foreign lands; or ruling monarchs in their private capacity. In every case they were maintained mainly for the gratification of the possessor or his personal friends, and rarely, if ever, associated with any systematic teaching or public benefit.

In England the earliest important collectors of miscellaneous objects were the two John Tradescants, father and son, the latter of whom published, in 1656, a little work called "Museum Tradescantianum; or, a Collection of Rarities preserved at South Lambeth near London."

The idea that the maintenance of a museum was a portion of the public duty of the State or of any municipal institution had, however, nowhere entered into the mind of man at the beginning of the last century. Even the great teaching bodies, the universities, were slow in acquiring collections, but it must be recollected that the subjects considered most essential to the education they then professed to give were not those which needed illustration from the objects which can be brought together in a museum. The Italian universities, where anatomy was taught as a science earlier and more thoroughly than anywhere else in Europe, soon found the desirability of keeping collections of preserved specimens, and the art of preparing them attained a high degree of excellence at Padua and Bologna two centuries ago. But these were generally the private property of the professors, as were nearly all the collections used to illustrate the teaching of anatomy and pathology in our country within the memory of many now living.

Though the experimental sciences and those which deal with the laws which govern the universe, rather than with the materials of which it is composed, have not hitherto greatly called forth the collector's instinct, or depended upon museums for their illustration, yet the great advantages of collections of the various instruments by means of which these sciences are pursued, and of examples of the methods by which they are taught, are yearly becoming more manifest. Museums of scientific apparatus now form portions of every well-equipped educational establishment, and under the auspices of the Science and Art Department at

South Kensington a national collection illustrating those branches of natural history science which have escaped recognition in the British Museum is assuming a magnitude and importance which brings the question of properly housing and displaying it urgently to the front.

Anomalies such as these are certain to occur in the present almost infantile though rapidly progressive state of science. It may be taken for granted that no scientific institution of any complexity of organisation can be, except at the moment of its birth, abreast of the most modern views of the subject, especially in the dividing lines between, and the proportional representation of, the various branches of knowledge which it includes.

The necessity for subdivisions in the study of science is continually becoming more apparent as the knowledge of the details of each subject multiplies without corresponding increase in the power of the human mind to grasp and deal with them, and the dividing lines not only become sharper, but as knowledge advances they frequently require revision. It might be supposed that such revision would adjust itself to the direction taken by the natural development of the relations of the different branches of science, and the truer conceptions entertained of such relations. But this is not always so. Artificial barriers are continually being raised to keep these dividing lines in the direction in which they have once started. Difficulties of readjustment arise not only from the mechanical obstacles caused by the size and arrangements of the buildings and facilities for the allocation of various kinds of collections, but still more from the numerous personal interests which grow up and wind their meshes around such institutions. Professorships and curatorships of this or that division of science are founded and endowed, and their holders are usually tenacious either of encroachment upon or of any wide enlargement of the boundaries of the subject they have undertaken to teach or to illustrate; and in this way more than any other passing phases of scientific knowledge have become crystallised or fossilised in institutions where they might least have been expected. I may instance many European universities and great museums in which zoology and comparative anatomy are still held to be distinct subjects taught by different professors, and where, in consequence of the division of the collections under their charge, the skin of an animal, illustrating its zoology, and its skeleton and teeth, illustrating its anatomy, must be looked for in different and perhaps remotely placed buildings.

The first consideration in establishing a museum, large or small, either in a town, institution, society, or school, is that it should have some definite object or purpose to fulfil; and the next is that means should be forthcoming not only to establish, but also to maintain the museum in a suitable manner to fulfil that purpose. Some persons are enthusiastic enough to think that a museum is in itself so good an object that they have only to provide a building and cases and a certain number of specimens, no matter exactly what, to fill them and then the thing is done; whereas the truth is the work has only then begun. What a museum really depends upon for its success and usefulness is not its building, not its cases, not even its specimens, but its curator. He and his staff are the life and soul of the institution, upon whom its whole value depends; and yet in many—I may say most of our museums—they are the last to be thought of. The care, the preservation, the naming of the specimens are either left to voluntary effort—excellent often for special collections and for a limited time, but never to be depended on as a permanent arrangement—or a grievously undersalaried and consequently uneducated official is expected to keep in order, to clean, dust, arrange, name, and display in a manner which will contribute to the advancement of scientific knowledge collections ranging in extent over almost every branch of human learning, from the contents of an ancient British barrow to the last discovered bird of paradise from New Guinea.

Valuable specimens not unfrequently find their way into museums thus managed. Their public-spirited owners fondly imagine that they will be preserved and made of use to the world if once given to such an institution. Their fate is, unfortunately, far otherwise. Dirty, neg-

lected, without label, their identity lost, they are often finally devoured by insects, or cleared away to make room on the crowded shelves for the new donation of some fresh patron of the institution. It would be far better that such museums should never be founded. They are traps into which precious—sometimes priceless—objects fall only to be destroyed; and, what is still worse, they bring discredit on all similar institutions, make the very name of museum a byword and a reproach, hindering instead of advancing the recognition of their value as agents in the great educational movement of the age.

A museum is like a living organism—it requires continual and tender care. It must grow, or it will perish; and the cost and labour required to maintain it in a state of vitality is not yet by any means fully realised or provided for, either in our great national establishments or in our smaller local institutions.

Often as it has been said, it cannot be too often repeated, that the real objects of forming collections, of whatever kind (apart, of course, from the mere pleasure of acquisition—sometimes the only motive of private collectors), and which, although in very different degrees, and often without being recognised, underlie the organisation of all museums, are two, which are quite distinct, and sometimes even conflicting. The first is to advance or increase the knowledge of some given subject. This is generally the motive of the individual collector, whose experience shows him the vast assistance in forming definite ideas in any line of research in which he may be occupied that may be derived from having the materials for its study at his own command, to hold and to handle, to examine and compare, to take up and lay aside whenever the favourable moment to do so occurs. But unless his subject is a very limited one, or his means the reverse, he soon finds the necessity of consulting collections based on a larger scale than his own. Very few people have any idea of the multiplicity of specimens required for the purpose of working out many of the simplest problems concerning the life-history of animals or plants. The naturalist has frequently to ransack all the museums, both public and private, of Europe and America in the endeavour to compose a monograph of a single common genus, or even species, that shall include all questions of its variation, changes in different seasons, and under different climates and conditions of existence, and the distribution in space and time of all its modifications. He often has to confess at the end that he has been baffled in his research for want of the requisite materials for such an undertaking. Of course, this ought not to be, and the time will come when it will not be, but that time is very far off yet.

We all know the old saying that the craving for riches grows as the wealth itself increases. Something similar is true of scientific collections brought together for the purpose of advancing knowledge. The larger they are the more their deficiencies seem to become conspicuous; the more desirous we are to fill up the gaps which provokingly interfere with our extracting from them the complete story they have to tell.

Such collections are, however, only for the advanced student, the man who has already become acquainted with the elements of his science and is in a position, by his knowledge, by his training, and by his observing and reasoning capacity, to take advantage of such material to carry on the subject to a point beyond that at which he takes it up.

But there is another and a far larger class to whom museums are, or should be, a powerful means of aid in acquiring knowledge. Among such, those who are commencing more serious studies may be included; but I especially refer to the much more numerous class, and one which it may be hoped will year by year bear a greater relative proportion to the general population of the country, who, without having the time, the opportunities, or the abilities to make a profound study of any branch of science, yet take a general interest in its progress, and wish to possess some knowledge of the world around them, and of the principal facts ascertained with regard to it, or at least some portions of it. For such persons museums may be, when well organised and arranged, of benefit to a degree that at present can scarcely be realised.

To diffuse knowledge among persons of this class is the second of the two purposes of museums of which I have spoken.

I believe that the main cause of what may be fairly termed the failure of the majority of museums, especially museums of natural history, to perform the functions that might be legitimately expected of them is that they nearly always confound together the two distinct objects which they may fulfil, and by attempting to combine both in the same exhibition practically accomplish neither.

In accordance with which of those two objects, which may be briefly called *research* and *instruction*, is the main end of the museum, so should the whole be primarily arranged; and in accordance with the object for which each specimen is required, so should it be treated.

The specimens kept for research, for advancement of knowledge, for careful investigations in structure and development, or for showing the minute distinctions which must be studied in working out the problems connected with variations of species according to age, sex, season, or locality; for fixing the limits of geographical distribution, or determining the range in geological time, must be not only exceedingly numerous (so numerous, indeed, that it is almost impossible to put a limit on what may be required for such purposes), but they must also be kept under such conditions as to admit of ready and close examination and comparison.

If the whole of the specimens really required for enlarging the boundaries of zoological or botanical science were to be displayed in such a manner that each one could be distinctly seen by any visitor sauntering through the public galleries of a museum, the vastness and expense of the institution would be out of all proportion to its utility; the specimens themselves would be quite inaccessible to the examination of all those capable of deriving instruction from them, and, owing to the injurious effects of continued exposure to light upon the greater number of preserved natural objects, would ultimately lose a large part of their permanent value. Collections of this kind must, in fact, be treated as the books in a library, and be used only for consultation and reference by those who are able to read and appreciate their contents. To demand, as has been ignorantly done, that all the specimens belonging to our national museums, for instance, should be displayed in cases in the public galleries, would be equivalent to asking that every book in a library, instead of being shut up and arranged on shelves for consultation when required, should have every single page framed and glazed and hung on the walls, so that the humblest visitor, as he passes along the galleries, has only to open his eyes and revel in the wealth of literature of all ages and all countries, without so much as applying to a custodian to open a case. Such an arrangement is perfectly conceivable. The idea, from some points of view, is magnificent, almost sublime. But imagine the space required for such an arrangement of the national library of books, or, indeed, of any of the smallest local libraries. Imagine the inconvenience to the real student, the disadvantages which he would be under in reading the pages of any work fixed in an immovable position beneath a glass case. Think of the enormous distances he would often have to traverse to compare a reference or verify a quotation, and the idea of sublimity soon gives place to its usual antithesis. The attempt to display every bird, every insect, shell, or plant which is or ought to be in any of our great museums of reference would produce an exactly similar result.

In the arrangement of collections designed for research, which, of course, will contain all those precious specimens called "types," which must be appealed to through all time to determine the species to which a name was originally given, the principal points to be aimed at are—the preservation of the objects from all influences deleterious to them, especially dust, light, and damp; their absolutely correct identification, and record of every circumstance that need be known of their history; their classification and storage in such a manner that each one can be found without difficulty or loss of time; and, both on account of expense as well as convenience of access, they should be made to occupy as small a space as is compatible with these requirements. They should be kept in rooms provided

with suitable tables and good light for their examination, and within reach of the necessary books of reference on the particular subjects which the specimens illustrate. Furthermore, the rooms should be so situated that the officers of the museum, without too great hindrance to their own work, can be at hand for occasional assistance and supervision of the student, and if collections of research and exhibited specimens are contained in one building, it is obvious that the closer the contiguity in which those of any particular group are placed the greater will be the convenience both of students and curators, for in very few establishments will it be possible to form each series on such a scale as to be entirely independent of the other.

On the other hand, in a collection arranged for the instruction of the general visitor, the conditions under which the specimens are kept should be totally different. In the first place, their numbers must be strictly limited, according to the nature of the subject to be illustrated and the space available. None must be placed too high or too low for ready examination. There must be no crowding of specimens one behind the other, everyone being perfectly and distinctly seen, and with a clear space around it. Imagine a picture-gallery, with half the pictures on the walls partially or entirely concealed by others hung in front of them; the idea seems preposterous, and yet this is the approved arrangement of specimens in most public museums. If an object is worth putting into a gallery at all, it is worth such a position as will enable it to be seen. Every specimen exhibited should be good of its kind, and all available skill and care should be spent upon its preservation and rendering it capable of teaching the lesson it is intended to convey. And here I cannot refrain from saying a word upon the sadly neglected art of taxidermy, which continues to fill the cases of most of our museums with wretched and repulsive caricatures of mammals and birds, out of all natural proportions, shrunken here and bloated there, and in attitudes absolutely impossible for the creature to have assumed while alive. Happily there may be seen occasionally, especially where amateurs of artistic taste and good knowledge of natural history have devoted themselves to the subject, examples enough—and you are fortunate in possessing them in Newcastle—to show that an animal can be converted after death, by a proper application of taxidermy, into a real life-like representation of the original, perfect in form, proportions, and attitude, and almost, if not quite, as valuable for conveying information on these points as the living creature itself. The fact is that taxidermy is an art resembling that of the painter or rather the sculptor; it requires natural genius as well as great cultivation, and it can never be permanently improved until we have abandoned the present conventional low standard and low payment for "bird stuffing," which is utterly inadequate to induce any man of capacity to devote himself to it as a profession.

To return from this digression, every specimen exhibited should have its definite purpose, and no absolute duplicate should on any account be permitted. Above all, the purpose for which each specimen is exhibited, and the main lesson to be derived from it, must be distinctly indicated by the labels affixed, both as headings of the various divisions of the series, and to the individual specimens. A well-arranged educational museum has been defined as a collection of instructive labels illustrated by well-selected specimens.

What is, or should be, the order of events in arranging a portion of a public museum? Not certainly, as too often happens now, bringing a number of specimens together almost by haphazard, and cramming them as closely as possible in a case far too small to hold them, and with little reference to their order or to the possibility of their being distinctly seen. First, as I said before, you must have your curator. He must carefully consider the object of the museum, the class and capacities of the persons for whose instruction it is founded, and the space available to carry out this object. He will then divide the subject to be illustrated into groups, and consider their relative proportions, according to which he will plan out the space. Large labels will next be prepared for the principal headings, as the chapters of a book, and smaller ones for the various subdivisions. Certain propositions to be illustrated, either in

the structure, classification, geographical distribution, geological position, habits, or evolution of the subjects dealt with, will be laid down and reduced to definite and concise language. Lastly will come the illustrative specimens, each of which, as procured and prepared, will fall into its appropriate place. As it is not always easy to obtain these at the time that they are wanted, gaps will often have to be left, but these, if properly utilised by drawings or labels, may be made nearly as useful as if occupied by the actual specimens.

A public exhibition which is intended to be instructive and interesting must never be crowded. There is, indeed, no reason why it ever should be. Every such exhibition, whether on a large or small scale, can only contain a representative series of specimens, selected with a view to the needs of the particular class of persons who are likely to visit the gallery, and the number of specimens exhibited should be adapted to the space available. There is, therefore, rarely any excuse for filling it up in such a manner as to interfere with the full view of every specimen shown. A crowded gallery, except in some very exceptional circumstances, at once condemns the curator, as the remedy is generally in his own hands. In order to avoid it he has nothing to do but sternly to eliminate all the less important specimens. If any of these possess features of historical or scientific interest demanding their permanent preservation, they should be kept in the reserve collections; if otherwise, they should not be kept at all.

The ideal public museums of the future will, however, require far more exhibition space than has hitherto been allowed; for though the number of specimens shown may be fewer than is often thought necessary now, each will require more room if the conditions above described are carried out, and especially if it is thought desirable to show it in such a manner as to enable the visitor to realise something of the wonderful complexity of the adaptations which bring each species into harmonious relation with its surrounding conditions. Artistic reproductions of natural environments, illustrations of protective resemblances, or of special modes of life, all require much room for their display. This method of exhibition, wherever faithfully carried out, is, however, proving both instructive and attractive, and will doubtless be greatly extended.

Such, then, is the primary principle which ought to underlie the arrangement of all museums, the distinct separation of the two objects for which collections are made; the publicly exhibited collection being never a storeroom or magazine, but only such as the ordinary visitor can understand and profit by, and the collection for students being so arranged as to afford every facility for examination and research. The improvements that can be made in detail in both departments are endless, and to enter further into their consideration would lead me far beyond the limits of this address. Happily, as I said before, the subject is receiving much attention.

However much we may be convinced of the supreme value of scientific methods of observation and of reasoning, both as mental training of the individual and in the elucidation of truth and advancement of knowledge generally, it is impossible to be blind to the fact that we who are engaged with the investigation of those subjects which are commonly accepted as belonging to the domain of physical science are unfortunately not always, by virtue of being so occupied, possessed of that most precious gift, "a right judgment in all things."

No one intimately acquainted with the laborious and wavering steps of scientific progress (I can answer at least for one branch of it) can look upon that progress with a perfect feeling of satisfaction.

Can it be said of any of us that our observations are always accurate, the materials on which they are based always sufficient, our reasoning always sound, our conclusions always legitimate? Is there any subject, however limited, of which our knowledge can be said to have reached finality?

Or if it happens to any of us as to

A man who looks at glass
On it may stay his eye,
Or if he pleases through it pass,
And then the heavens espy,

are not those heavens which are beyond the immediate objects of our observation coloured by our prejudices, prepossessions, emotions, or imagination, as often as they are defined by any profound insight into the depth of nature's laws? In most of these questions an open mind and a suspended judgment appear to me the true scientific position, whichever way our inclinations may lead us.

For myself, I must own that when I endeavour to look beyond the glass, and frame some idea of the plan upon which all the diversity in the organic world has been

THE JULIEN SYSTEM.

In a recent number we described the extension of this system from the Fourth Avenue line. We are now able to illustrate car No. 8 as used in this system, and it will be seen that some new features are introduced into the construction of this car due to the change of motive power from horses to batteries. Fig. 1 shows the car referred to. Each car has two 10 h.p. motors mounted on the truck, which is independent of the car-body. Each

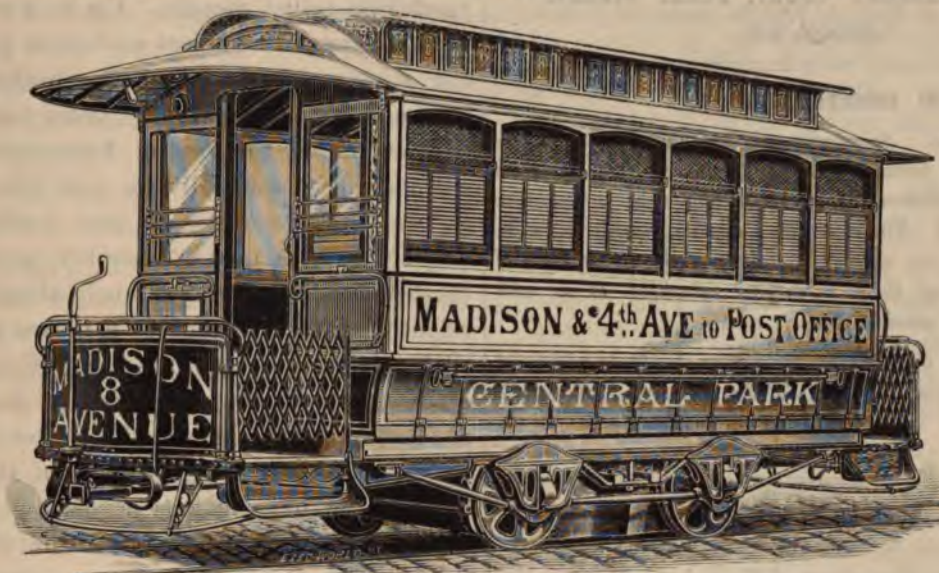


FIG. 1.—Julien System—Car No. 8.

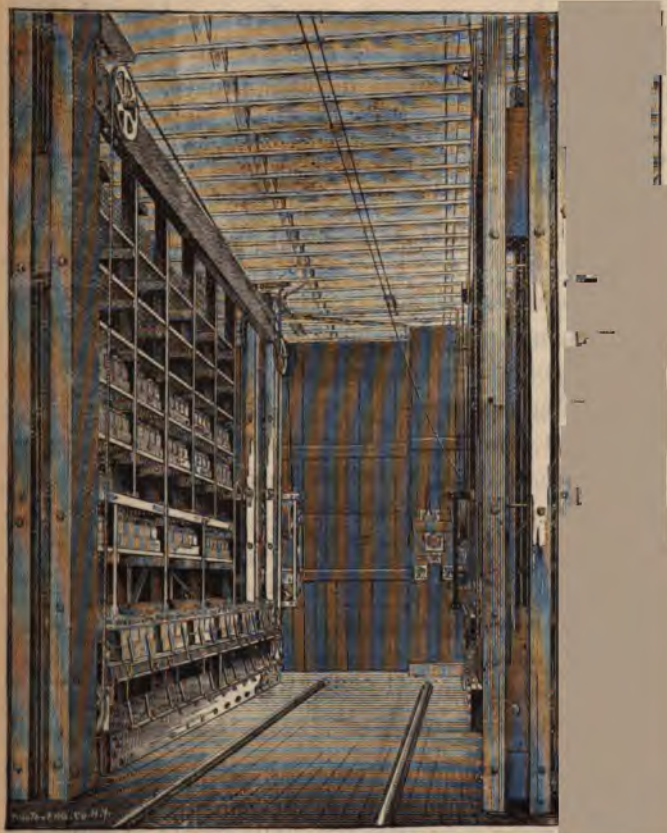


FIG. 2.—Julien System—Changing Station.

brought about, I see the strongest grounds for the belief, difficult as it sometimes is in the face of the strange, incomprehensible, apparent defects in structure, and the far stranger, weird, ruthless savagery of habit, often brought to light by the study of the ways of living creatures, that natural selection, or survival of the fittest, has, among other agencies, played a most important part in the production of the present condition of the organic world, and that it is a universally acting and beneficent force continually tending towards the perfection of the individual, of the race, and of the whole living world.

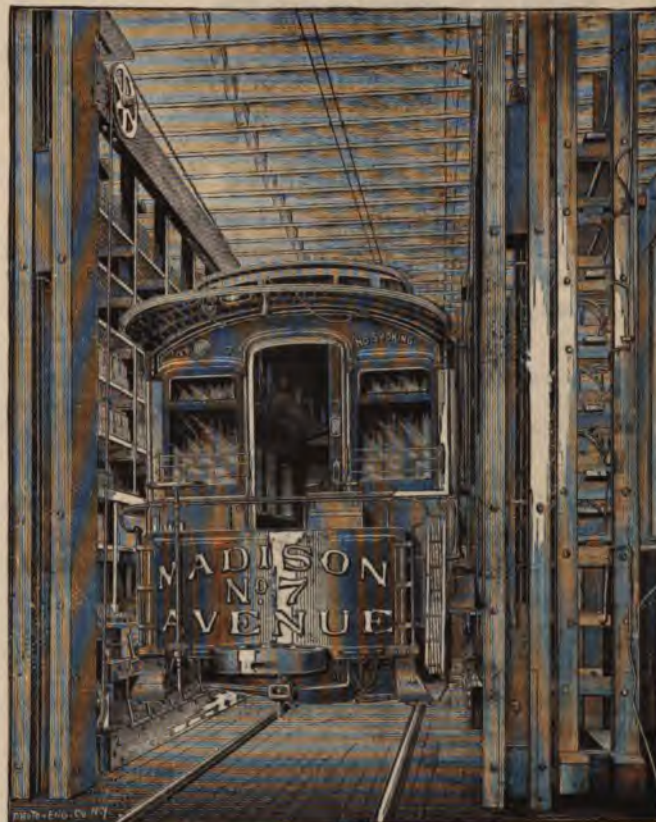


FIG. 3.—Julien System—Changing Station with Car.

car requires 216 accumulators, and the methods of changing the dead from the living cells is shown in Figs. 2 and 3. The car runs into the station between two elevators, 16ft. long, composed of two shelves, the lower one containing the newly charged cells, the upper one to receive the discharged set as withdrawn from the car. The elevators are run by stationary motors, and the time occupied in changing the cells is stated to be three minutes. These racks, with motors and all the paraphernalia required, occupy a space of 24ft. by 7ft. on each side of the car.

THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence ; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices :

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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IMPORTANT NOTICE.

We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No paper that we know ever refuses Subscribers or Advertisers. Nor do we; in fact, we invite them, believing that they will get full value for their money.

Specimen copies of the paper will be sent on request.

THE PRESIDENT'S ADDRESS.

"Every man to his last" is as true of presidents and presidential addresses as it is elsewhere. When we come to consider it, what a multifarious mind this world has. The speciality that delights one person is abhorred of another, and no doubt this is in its way good, because it keeps the ranks of the specialists rather meagre. Up to a point the men who understand a subject are legion, past that point the stars only shine, and the multitude is quite agreeable to let them shine. Every year, then, a star is chartered by the British Association to leave the realms where space divides him from his fellows, and to make a more or less brilliant meteoric display before a mixed assembly, an assembly, by-the-bye, which cares as much about science and scientific things, except as a means to an end on that particular evening, as about their neighbours' dresses, for a good sprinkling of hearers always consists of ladies. Hence the flutter of excitement in the assemblage is greater when the star leaves entirely the high regions he usually traverses and comes down to the lowermost stratum of this mundane sphere, then every hearer who can hear understands something of the discourse, and goes away flattered that even he or she understands something of this subject. Ever after the address forms the high-water mark of scientific discussion between friends, who direct every discussion that can be directed into certain channels, and clinch every argument with, You remember what Prof. A, B, or C said in his presidential address at the meeting of the British Association.

The presidential address this year is within the comprehension of everybody, and, as it deals with a most important general subject, should have a correspondingly good effect. "The value of museums" is the text, which might be expanded into two heads: (1) educationally; (2) as a fashionable lounge. Prof. Flower expatiates on both these heads, and tells us the best arrangements to be adopted to obtain the best effect. If we were to consider the question of museums from the narrow platform of the electrical engineer, we should be able to find little that was good in them. But electrical engineering is only one phase of the application of science that agitates the mind of the universe, and other branches may largely be benefited by the extension of museums. Almost all the mining industries especially would so benefit, as would the textile manufacturers. The mining, the hydraulic, and the civil engineer should be good geologists, and not bad palæontologists. English trained engineers are to be found all the world over, and many of them have to thank the School of Mines for the thorough training received to fit them for the work they have to do. We are inclined to doubt the value of the small specimen sets so industriously advertised and foisted

upon teachers, and although the practice long since followed by the writer may not be possible in all cases, it was found from experience to be better than any other. It was in years gone by that the plan was carried out—which was to tramp the whole district within walking range of the pupils, and periodically to spend a day in the Jermyn-street Museum. The notes of the former work induced a desire for fuller information, which was obtained in the museum. Putting aside what may be looked upon as the scientific value of the museum, we would like to refer to another value which, so far as we know, has not been discussed. The Anglo-Saxon race, if it is anything, is a migratory race—given to settling everywhere at the expense of the aboriginal inhabitants. Well, the emigrants to Australia, to Canada, and to other of our dependencies, cannot, as a whole, be dubbed scientific experts, yet it would be valuable for them to know something of soil, of fauna, and of flora indigenous to the parts in which they are to settle. Failure has had to be written again and again, because of the lack of a little knowledge. Information has had to be gained from experience which might have been obtained by a day's teaching in a museum, and it is from such considerations as these that we conclude that museums should be arranged for the rudimentary education of the million rather than the advanced education of the few.

There is the further point to be considered in the advocacy of museums, that it is in them that the filtration of knowledge from the experts to the populace can best take place. Books may, and do, carry out this training, lectures in classes are necessary, and addresses such as that we are now commenting upon are valuable beyond others, from the fact that they embody the newest and most interesting discoveries. But the man who seeks abstruse knowledge is in reality of the same nature as the child who seeks general knowledge, and, in the same manner that it is impossible to teach a child so well from books or from words as from actually seeing and handling things, so for higher scientific knowledge, one glance all round at a specimen, one thorough examination of an actual object, does more to fix the necessary qualities and attributes of the matter in question than almost any amount of reading or of listening to lectures. Object lessons are the order of the day, and object lessons for men as much as for children. It follows necessarily that if museums are to be of real and teaching use, they must be inspired, organised, and arranged by those from whom something can be learned, from whom knowledge can filter, and this being so, there seems to be nothing worthier of the attention of our most brilliant specialists than that of the development to the best advantage of museums. The old idea of a museum as a curiosity

shop is, we are glad to say, now practically defunct. The object of a museum is to teach, and its right aim is to be a place in which, if he will, a person can learn, and learn better there than anywhere else, except in the actual works of a manufacture or place of growth of a natural history specimen. We are glad to see Prof. Flower lay stress on two points: (1) that a museum should be well labelled, and (2) that a museum should be for the few earnest students and for the general public at the same time. As for labelling, it is not everyone that wishes to wade through a catalogue, and often desires only to see those things which most interest himself personally. The chief points given on a label are sufficient to him for most specimens; and further details can then be obtained of those he more specially requires. There is another incidental but important advantage to be gained in following Prof. Flower's suggestion, which, while we are talking of museums, we may mention, and this is the absence of headaches, which the constant shifting of the focus of the eye from object to catalogue causes. But this is by the way. The second point is far more important. General visitors should see the general features and be instructed and amused, but, hidden away from too careless gaze, and yet instantly accessible, should be all those more minute, more detailed, more scientifically interesting objects which the real student can pore over, examine, or handle at his ease.

There is a certain class of museum that is exceedingly interesting, and would admirably suit the fashionable lounge. It may be termed the historic or archæologic, which exhibits principally apparatus long since abandoned for something better. It shows that development is gradual, and that perfection is not arrived at in a moment. The dwellings and instruments of to-day are not those of the years gone by. In our own branch, the dynamo of to-day is not the dynamo of even ten years back, and the same may be said both of the incandescent and the arc lamp. Auxiliary apparatus has sprung up, each portion of which introduces an improvement, and thus the history of our own industry could be written clearly and unmistakably in a well-arranged historic museum. So might that of telegraphy and that of telephony. Edison is said to have ransacked the world to obtain the best material to carbonise for his lamp filaments. The results of his experiments would form a chapter in the museum, with a moral that could be read by the veriest beginner. In a field such as our own, the constant development and evolution of the applications of electrical science by man is one of the most interesting at the present stage of history, and will tend to become more and more important. The history of the development would well be written large in such a museum. Not only would historic articles, such as

the coil that Faraday used in his experiments, the first commercial machine made after those experiments (the prototype of all our modern dynamos), the instrument by which the first telegram was flashed across the Atlantic cable, the first practical incandescent lamp—not only would these find their fitting and honourable resting place, but a place of studious resort for the illustration of important facts or laws, and specimens of materials might make it of lasting commercial benefit. To us also, then, these incitements of the President of the British Association may well come with practical meaning, and it might be well if, among their other duties, those engaged in the higher branches of our particular subject were to add to their duties that of encouraging, organising, and rendering universally useful a museum such as has been spoken of at this meeting at Newcastle-on-Tyne.

NEW YORK NOTES.

(FROM OUR SPECIAL CORRESPONDENT.)

A Wholesale Exposé.
The "Sun" Sheds Light upon Mr. Harold P. Brown's Methods.
The "Chief Electrocuter" under a New Aspect.
He was "On the Make."
His Friends and Backers in the Anti-Westingshouse Crusade.
Welding Rails by Electricity.
Deep-Sea Temperatures.
The 1892 Exhibition to be Inaugurated from Madrid.
General Boulanger's Voice Heard in New York.

NEW YORK, August 30, 1889.

The sensation of the week in electrical circles has been the exposure made by one of the leading New York dailies of Mr. Harold P. Brown's method of running the "electrocution" business to his own pecuniary advantage and for the detriment of the Westinghouse system. Last Sunday, the *Sun* devoted about five columns and a half to the publication of correspondence between Mr. Brown and various managers and officials of electric lighting companies and others. It is notorious that strong suspicion has existed in many quarters as to Mr. Brown's disinterestedness in the matter of electrical execution notwithstanding the attitude of scientific zeal and pure philanthropy which he has always striven to maintain, but a perusal of these letters shows very clearly that Mr. Brown was actuated entirely by a keen desire to discredit the Westinghouse system before the general public, and by a still keener pursuit of the "main chance" on his own behalf. The *Sun* offers no proof or assurance of the genuineness of the letters, and carefully abstains from stating the manner in which they were obtained—perhaps there may be a Pigott in the case after all, but it scarcely seems admissible—and as yet no one of the many whose names are printed as correspondents of Mr. Brown has denied the authenticity of any of the letters, and Mr. Brown himself, who is generally only too eager to write columns of matter when his pet hobby is being discussed, has not yet been heard from.

The *Sun* prefaces the publication of the letters by the following testimony given by Mr. Brown during the hearing of the Kemmler case last month:

Q. Are you connected in any way with any of the electric lighting companies?

A. No, sir.

Q. Or have you any connection with the Edison Company?

A. No, sir.

Q. Or with Mr. Edison?

A. No, sir, except a personal acquaintance.

The first document cited is a letter from Mr. Brown's father, dated September 16, 1888, from which the follow-

ing quotation is given: "I thank you for the papers relating to your discussion. How did the matter end? And did it advance your interest any? I was a little surprised at your statement that you were not connected with any electric company. I thought you were." Probably others were as much surprised as Mr. Brown, sen., both on the occasion referred to and at the hearing of the Kemmler case this summer.

Following short letters of slight interest, comes one from Mr. Brown to the Thomson-Houston Electric Company at Chicago, thanking them for their authorisation to challenge the Westinghouse claims concerning high efficiency. Mr. Brown thinks that "the result will be a deathblow to that method of doing business." In the same letter he states that the December challenge to Westinghouse cost him 275dols. for a single insertion in the *Herald*, *World*, *Sun*, and *Tribune*, the marks of "adv." being in each case omitted. The *Sun* remarks that, so far as that paper is concerned, this statement is an absolute falsehood.

In the next letter Mr. Brown tells Mr. Edison how he is striving to induce the Mayor of Scranton to abolish from that town the "high-tension alternating current, which is unsuited for commercial lighting," and asks Mr. Edison for a testimonial, which the wizard duly furnishes. Dr. Macdonald, of the State Asylum for Insane Criminals at Auburn, then writes to Mr. Brown suggesting that he send to the Superintendent of State Prisons an estimate of the cost of electrical execution plant for one prison, together with a definite proposition to furnish and set up the apparatus, and to put it into practical operation, the proposition to cover Mr. Brown's services and those of his assistant "electrocutters."

Mr. Brown seems to have acted upon this suggestion with great promptness, for eight days later he writes to Mr. Edison saying that he has been authorised by the State authorities to purchase alternating-current dynamos made for electric lighting on the "converter" system for the electrical execution plants. Mr. Brown proposes to buy Westinghouse dynamos, one of which, taking it for granted that Westinghouse will not reply to Mr. Brown's "authorised" challenge to compare his plant with that of the Thomson-Houston by means of a three months' test, is to be used for the purpose of a public efficiency test. This would require an investment of 7,000 to 8,000dols., until the first execution proves that the plant is suitable. Mr. Brown calmly proposes that Mr. Edison should back him to the extent of 5,000dols., and thereby enable him to carry death and destruction into the Westinghouse ranks. Mr. Edison evidently did not "part," as the rest of correspondence is chiefly with the Thomson-Houston Company, of Boston. This company and Messrs. Frank Ridlon and Co., dealers in second-hand electrical apparatus, also of Boston, arranged the purchase of the Westinghouse plant for Mr. Brown; much of the correspondence relates to the peculiar manner in which the machines were purchased, and minute instructions are given by Mr. Brown as to the removal of all marks by which the machines might be traced, and as to careful packing in order to prevent them from "accidental" damage in transit. Mr. Brown's careful attention to his pecuniary interests is evidenced in a letter addressed to him by the Thomson-Houston Company, in which, after offering him substantial discounts and "drawbacks" on Westinghouse plant purchased through them, they say: "We will pay you on account of expenses attending the Baltimore test one thousand dollars, and will consider that we are held to pay you on account of future expert services an additional amount equal to five hundred dollars." Subsequently Mr. Brown, seeming to think that the purchase of Westinghouse plant drags somewhat, in a letter to the Thomson-Houston Company, darkly hints that tremendous pressure is being brought to bear from Pittsburgh "to prevent the test and to get other apparatus than theirs used, offering decided inducements, and every day's delay helps them. . . . There is a chance for them to overthrow the deal, and you can understand that this would be very detrimental to certain Boston interests." In another letter relating to the method of paying for the machines, Mr. Brown says: "I have withstood tremendous pressure and tempting offers to use other machines for that pur-

pose, but have, nevertheless, kept my agreement to the letter."

I have given above but a brief synopsis of the correspondence, which, though highly interesting, is disappointing in some respects, as there are many omissions of replies to some of Mr. Brown's letters. Some of these missing letters would have thrown more light on the subject, but it is obvious that an extremely discreditable conspiracy has existed, and the active ringleader is shown up in a very poor light indeed. Everybody knows that the inventor of the guillotine was the first to fall a victim to the creation of his own brain, and it would now seem that the chief exponent of "electrocution" has wrought his own professional extinction before he has had a chance to switch a murderer into the next world.

The West End Railway Company, of Boston, which owns the largest electric railway system in the country, is about to relay its entire track, some 150 miles in extent, with heavy rails. The work has been delayed by the Johnstown flood, as the rails are being made at the Cambria Iron Works, which were partially wrecked by the flood. When the new rails are laid it is expected that running time will be reduced by one-half, thereby doubling the capacity of the line. In laying the new tracks a Thomson-Houston electric welding machine will be used, and the rails will be welded into lengths of 300ft. This innovation in railway construction will doubtlessly render the track exceptionally smooth.

The surveying schooner "Grampus," sent out by the United States Fish Commission to investigate deep-sea temperatures between the New England Coast and the Gulf Stream, has made several trips, and is about to start on another. About 100 soundings have been made, chiefly in depths not exceeding 500 fathoms; 17 thermometers and two water cups are sent down each time. Evidence of the warm Gulf Stream water has been found within 35 miles of the coast, but here it is only a shallow layer, five or 10 fathoms deep. Beneath this warm stratum, which gradually increases in depth to 25 or 30 fathoms as the distance from land increases, there is a sudden fall in temperature, which in some cases reached as much as 16 or 18deg. within a vertical distance of five fathoms. Nearer the Gulf Stream a warm band is also found underlying the colder water, the same sounding frequently showing the temperature at 50 to 100 fathoms to be 5deg. to 10deg. higher than that at 30 or 40 fathoms. At 500 fathoms the temperature was usually below 40deg. F.

The latest proposal regarding the 1892 Exhibition is that Spain's connection with the discovery of America be signalled by the exhibition being inaugurated by young Alfonso XIII., who, in his palace at Madrid, is to touch an electric button, and, 5,000 miles of continuous communication having been arranged *ad hoc*, set going the machinery of the exhibition.

When General Boulanger was informed that a report was current to the effect that he was about to remove to New York he is said to have qualified it as "an infamous falsehood." However, he has sent his voice on by phonogram, and a feature of the phonographic exhibition at the panorama of the Battle of Gettysburg is a brief address from the redoubtable general "To my friends in America." The record has just been received from London.

METHODS TO DETERMINE THE EQUIVALENT AREA OF ARMATURES.

BY ERVIN S. FERRY.

In many calculations upon the dynamo, it is necessary to know the strength of the magnetic field in which the armature revolves, or, in other words, the number of lines of force that traverse the armature during its rotation. The most convenient way to determine this strength of field of the dynamo is to find what is called the "equivalent area of the armature." By the equivalent area of a coil of wire is meant its capacity for cutting lines of force in a given magnetic field. The area is proportional to the size of the coil, and to the intensity of the magnetic field in which it revolves.

The simplest and perhaps the least accurate method to determine the number of lines of force traversing an armature is to take S. P. Thompson's new equation of the dynamo,

$$E = n C N;$$

when E is the total E.M.F. generated, n is the number of revolutions per second of the armature; C , the number of conductors on the armature, and N the number of lines of force traversing the armature. Then equating for N we get

$$N = \frac{E}{nC};$$

where n and C are known. But the difficulty lies in the fact that E cannot be easily determined accurately. It may be determined approximately if the following conditions are made good. Separately excite the pole-pieces to the same degree as when the dynamo is running under its normal conditions, then observe the voltage at the brushes. Then substituting this E in the previous equation, we should obtain N .

But there are two strong objections to this method. First, it is very difficult to attain the same degree of magnetisation of the poles by separate excitation as when the machine is running normally with part of the current generated being absorbed in the magnetisation of the poles. Second, no account is taken of the E.M.F. lost internally by heating and Foucault currents.

Another way to find N , also suggested by S. P. Thompson, is to wind a single turn of insulated wire around the armature, parallel to the conductors, placed in the line of commutation of the armature, and then magnetise the pole-pieces by some external current to an amount equal to its normal value. On making and breaking the exciting current, E.M.F. is generated in the turn upon the armature, which may be measured by a ballistic galvanometer. This E.M.F. is proportional to the number of lines of force transversing the coil. Now, to determine the number of these lines of force, we take a coil of wire of known geometrical area, revolve it in a magnetic field whose intensity is known, and compare the deflection due to the E.M.F. generated by this standard-coil to that from the turn around the armature.

Then if N equals the number of lines of force passing between dynamo poles; N' , the number cut by revolving the standard-coil; d_1 , the galvanometer deflection due to the single turn; and d_2 , the deflection due to the revolution of the standard-coil,

$$N : N' :: d_1 : d_2.$$

Or, since the equivalent area is proportional to the number of lines of force in the two fields,

$$A : A' :: d_1 : d_2.$$

By revolving the standard-coil in the field of the horizontal component of the earth's magnetism, we know the number of lines of force cut by the coil to be equal to its geometrical area in centimetres times .184. This product is the equivalent area of the coil. Substituting this value for A' , and the observed deflections d_1 and d_2 , we get the equivalent area of the turn round the armature. If the number of lines of force is desired, divide this equivalent area of the turn by its geometrical area, and we have the number of lines of force per unit of area.

We now see that we may define "equivalent area" as the geometrical area multiplied by the number of lines of force passing through this area per unit of area. This method of determining the equivalent area of the armature, however, is open to two faults: first, the difficulty of separately exciting the poles to a degree equal to their normal magnetism when the machine is running; second the value thus obtained is the area of the armature only when the dynamo is at rest.

The next method to determine the equivalent area of armatures is called for brevity the method of "floppages." There are two ways in which this method may be applied; the method of constant resistance and variable deflection, and the method of constant deflection and variable resistance. The *modus operandi* of the former method is as follows: The armature is mounted upon a cradle so that it can be revolved through some convenient angle in the

earth's field. Then the brushes of the armature, the standard-coil, and a delicate ballistic galvanometer are all connected in series. Now, alternately revolve the armature and the standard-coil through the same angle, and if the galvanometer deflections from the coil and the armature are due to a rotation in the same component of the earth's magnetism, then these deflections are proportional to the equivalent areas of the coil or armature producing them. So that we have as before:

$$A : A' :: d_1 : d_2$$

By revolving both coil and armature in the known field of the horizontal component of the earth's magnetism, the number of lines of force cut by the armature may be determined as in the previous method.

In the method of constant deflection and variable resistance, the armature and the coil are separately connected to the galvanometer with an accurate resistance box in each circuit. This connection is best done by means of a six-way switch, thereby using the same resistance box in both circuits. By this arrangement we can control the respective deflections from the armature and the coil by inserting resistance in the respective circuits, so that we can get the deflection from the coil and the armature equal. Then the areas are proportional to the resistance in circuit, or

$$A : [A'] :: R : R'.$$

These two methods of floppages give the same area. It makes a difference in the area found by these methods of floppages, whether the armature is pointing north and south, or east and west. The reason is that the shape of a single armature-coil is oblong instead of circular. From the direction of the magnetic dip we see that a horizontal circular coil will always contain the same number of lines of force in whatever direction it is placed, with respect to the points of the compass. We also see that in the case of an oblong coil this is not so. If its longer axis is placed north and south it will contain a certain number of lines of force; but if the longer axis is placed east and west the coil will contain a greater number of lines of force. The reason of this is that the lines of force are evenly distributed parallel to the dip, so that on cutting a horizontal plane they are nearer together in the east and west direction than in the north and south direction.

In our experiments on this point with an armature of the Thomson-Houston incandescent type, it was found that the equivalent area of the armature, when north and south, was 73,024 square centimetres, while the area, when armature pointed east and west, was 73,825 square centimetres.

The method of floppages is open to some serious objections, among which may be noted, first, the area found is not the area when under working conditions, when the machine is running and when various heating and Foucault effects occur that do not occur when the armature is still. Second the area thus found is an incorrect value, even for a motionless armature. The reason of this is not far to seek. The great mass of iron core inside the armature-coils attracts into the armature more lines of force than would pass through the armature were there no iron in it. The standard coil has no iron in its construction, so that the ratio really is

$$d : d' :: A : A' + k;$$

where k is a constant that cannot be directly determined, depending upon the mass and the purity of the armature core.

Having now studied the errors and imperfections of these methods, it remains to describe a method by which they can be almost entirely avoided. If we wind a turn of fine insulated wire around the armature, parallel to the conductors terminating at a two-part commutator, we can compare the E.M.F. generated by this coil to that generated by the armature, when the armature is running under normal conditions. As the geometrical area of this turn is known, we can find the equivalent area of the armature by the ratio,

$$A : A' :: d^2 : d'^2.$$

The equivalent area of the same armature as used in the former experiments was found by this method to be 59,229 square centimetres. This result is much less than that

obtained by the previous methods, as was expected before this method was tried. From this disparity in the two determinations, we perceive the great effect the iron core exerts in the method of floppages. By this method of the coil around the armature, the area obtained is a value in which all the conditions of a machine in normal operation are accounted for, such as heating and Foucault effects. Again, there are fewer mechanical and technical difficulties to be overcome in this method than in any of the others investigated.

This difference is well brought out when we consider the difference in the voltage dealt with in the various methods. The voltage given by revolving the standard-coil was determined to be 0.0015 volts. The galvanometer employed was so delicately adjusted that this 0.0015 volts gave a deflection of 355 millimetres, and as deflections could be accurately read to one millimetre, the galvanometer was sensitive to a change of potential of 0.000,004,32 volts. The E.M.F. generated by revolving the armature in the earth's field was 0.0056 volts. In comparison with the extreme sensitiveness of galvanometer needed in the method of floppages with that required in the method of coil around armature, we find that in the latter case the voltages obtained from the armature and the coil around the armature were 143.26 volts and 5.141 volts respectively.—*Electrical World*.

ELECTRIC RAILWAYS.*

BY GEO. W. MANSFIELD.

(Concluded from page 198.)

We now have thirty-two cars in operation, and observations, in so far as they have been taken, show a marked decrease in horse-power per car. At Richmond, Va., some rough tests gave the electrical horse-power required per car at the station as from 4 to 5. On the Asbury Park road, at Lafayette, Ill., the figures of Dr. Bell show the remarkable low figure of 2.5 e.h.p. There are a number of circumstances on this road that would tend to make this figure so low. The cars are smaller than those ordinarily used, and I should judge that there were other circumstances entering into the calculation that would tend to reduce it. However, it well shows, possibly, one extreme in railroading.

The other extreme might be cited in the case of the Lynn road, Highland division. Here only one car is in operation. In the course of its route it ascends a hill graded at the rate of 8.7 per cent. for 300 ft., and immediately passes down on the other side. In this case the engine was indicated. Five cards were taken when the car was ascending the grade, the average of which was 52.2 h.p. If we allowed a dynamo efficiency of 90 per cent. this would indicate an electrical horse-power of 47 h.p. This is, unquestionably, a very extreme and exceptional case. I might add, incidentally, that the car pays handsomely.

At Plymouth, Mass., a road having many heavy grades, the maximum being over 10 per cent., and operating but three electric cars each with tow cars, the electrical horse-power at the station per car was approximately 7.7 h.p. On the cars the extremes vary obviously according to speed, grades, load, etc. It frequently reaches from four to five times the average value during total time. In Lynn the variation is enormous. In Cambridge the current frequently rises to from 65 to 70 amperes, or about 42 h.p. Especially is this the case on starting.

You can see from these figures the impossibility of giving only the most approximate figures in this direction unless every detail as to operation and conditions are known.

I feel, however, that on roads having no grades over 5 per cent., and operating under 10 motor cars with tow cars, 15 h.p. per car would be a safe figure for dynamo capacity. On large roads this figure could be reduced to 12 and possibly 10 h.p. per car, while on small three or five car roads with heavy grades 18 or 20 h.p. might not be any too much.

* Paper read at the National Electric Light Convention at Niagara Falls.

At Cambridge tests show that of the total time consumed by a car in a round trip, it was taking power only 61.8 per cent. of the time, and that 6.7 per cent. of the total time the car was stopped.

At Washington, where the streets were freer and not so thickly populated, the above figure for time when power was used rose to 66 per cent.

Neither of these roads are what you might call large. It seems, however, that from 30 to 40 per cent. of power in excess of the absolute requirements can be planned for. I do not think, however, that this can be implicitly relied upon as in other power business, since there are many factors in the general operations of a railroad system that might at any moment tax the central station to its utmost. In regard to total electrical and total commercial efficiencies, it is impossible for me or anyone else to give accurate figures. There are so many fluctuating factors entering into such a determination that whereas a test made to-day would give me certain figures, a test made to-morrow or a week later would give me entirely different figures. The time factor must enter largely into such a test.

From estimations based upon many figures, I feel certain that a total electrical efficiency of at least 70 per cent. can be obtained, and a total commercial efficiency measured from the indicated horse-power of the engine to the car-wheel horse-power (W.H.P.) of from 45 to 50 per cent. If the road-bed, rolling stock, and all the electrical apparatus is maintained as it should be, I hope and see no reason why this figure cannot be exceeded.

Unquestionably, to the railroad man, one of the most vital points is the cost of repairs. We all know that in so far as power is concerned a horse-power can be produced and delivered 10 hours per day the year round, with a profit at about 75dols. per year. The cost of maintaining a horse for only about four hours' work per day on a horse car is not far from 190dols.

There is one point which is of vital interest to the managers of electric light companies, and that is how they shall charge the railway companies for the power which they desire. I have already shown you that it is an exceedingly difficult thing to estimate upon the requisite power, as the conditions are so fluctuating and so variable. After, however, the question of the amount of power has been settled, the next point to determine is whether they shall charge the railway company by the hour, by the day or by the car mile. We have a large number of roads already hiring power of local companies; all of the methods just mentioned are in use. Upon small roads, where the schedule of the railway company is such that they have only a few cars running continuously, meeting emergencies by extras, and where the grades are heavy, a satisfactory basis has been to charge so much per day per car, the price ranging all the way from 3dols. to 5dols., 6dols., and even 7dols. When the roads are of moderate size, or are subject to many variations and sudden demands on the part of the public for better facilities, or when the line runs to some resort and the main bulk of business lay in picnics, etc., charges on the hour basis is, sometimes preferred. This price varies from 15 to 30 cents per hour. On larger systems, where the schedule is definite and fixed, the mileage basis is the preferable by far. The prices on this basis range from two to six cents. You can readily see that if the cars ran at infrequent intervals, and if the morning and evening traffic was especially heavy and required a larger number of cars, while during the major part of the day only a few cars were out, the mileage basis would be quite unsatisfactory, since on the whole you would have to make steam possible for the maximum railroad output, and maintain it throughout the day. All of these estimates, however, can only be determined by knowing the local conditions and circumstances.

In the East, where coal ranges from 4dols. to 5dols. per ton, naturally the prices could not compete with the railroads of the natural gas and coal regions where fuel can be obtained for almost nothing, as in some cases for 10 cents per ton.

I would like now to enter a wedge here in favour of the very best of construction. Your own experience has pro-

bably dictated that there is no economy if the original construction be put in with either inferior or faulty material or apparatus. It is more important in railroading than possibly in lighting that the overhead construction, the track circuit, the wiring of the cars and all other details be as perfect as it is possible for the best skill and brains to make them.

If the light companies would require proper and reasonable guarantees in this direction, whenever they do supply power, it would not only be a surety in regard to their own protection, but also would be a strong inducement for the very best of construction work.

The railroad man should see that it is for his interests, since there is no trouble that will consume profits more rapidly than breakdowns. There is no excuse now for electrical breakdowns. When such do happen it is either carelessness or cheap construction.

Railroading is an exact business. The cars must be ready and go precisely on time. Delays in railroading are ruinous. All such can be avoided by perfect honest work. I call upon electric light men to strongly urge this most vital of all considerations upon the railroad world. It is an experience we have gained at a tremendous cost. Is it not to our interests to see that others becoming associated with us do not suffer? Should not all electricians bend all their energies toward making this new and richly promising field a magnificent success? Have you not millions to gain and nothing to lose? Are you ready for it? Are you going to do it?

There are some 1,600 central electric light stations already located throughout the country, and some 425 railroad companies that sooner or later will have to have electric power. Is there any reason why you should not do it? I know of many a station that has to stint and save to tide over the year's dull seasons. You have no day circuits, are held by the sun to one schedule and by the moon to another. The municipal authorities jump at you from behind one post, and your commercial customers from behind the next. Stygian darkness is ever your salvation, and all conditions have to be met and illuminated by your beautiful light. You cannot afford to lose anything. Here is an opportunity for still one more chance at profit. If necessary, enlarge the scope of your charters. It will pay you. Your securities will be worth more, and can be more easily and satisfactorily placed. Railroads have an older and better standing in the financial world and on the money market than electric light companies. Can you afford to let the opportunity go by? From careful research, my own judgment would be that in many cases it would be the company's salvation. I believe the time is rapidly coming when great electric stations, from 5,000 to 20,000 h.p., are to be established. There are plants of from 5,000 to 10,000 h.p. already built for manufacturing purposes. I have been told that the Calumet and Hecla plant has in the neighbourhood of 12,000 h.p. The New York Steam Heating Company have about 10,000 h.p. of boiler capacity in their stations at Greenwich, Conn.

There are many mills equipped with power of from 1,000 to 5,000 h.p. Even our ocean steamships are plants of from 8,000 to 12,000 h.p. Why cannot electric plants of such power be built? Why are they not? Is there no business enough in lighting, power, and railroading? Almost every station I go into the country over is adding to its capacity. "New occasions teach new duties, time makes ancient good uncouth." The horse is uncouth. Electricity is our life.

Electric Cure for Blight.—An interesting experiment in an effort to discover the cause of blight of pear and apple trees has been made by Henry Roby, of Burlington, Vermont, U.S. He was impressed by the fact that trees had often shown blight suddenly without any apparent cause, and it occurred to him that possibly the trees were affected by electricity during showers. He took a large copper wire and bent it so that it would pass over the trees, the end being pressed into the ground as an arrester. The trees thus protected during the present season are in perfect condition.

DUBLIN.

In our last issue we gave the result of the investigation of the Dublin authorities into the lighting question—that they had determined to obtain a license to authorise the Corporation to supply electricity. The elaborate report presented by the committee on electric lighting to the Council contains three appendices, the first of which we give herewith, the second being an extract from Major Marindin's report to the Board of Trade, and the third an account of expenses incurred.

APPENDIX A.

Notes of the Information obtained in regard to the Electric Lighting of the several Cities and Towns visited by your Sub-Committee.

LIVERPOOL.

The Liverpool Electric Supply Company have had a license from the Board of Trade since the early portion of last year, and this year have got a provisional order with the consent of the Corporation. In this provisional order (which is for certain portions of the city only) the Corporation have had inserted the requisite clauses for their protection as regards the mode of laying the mains and taking up and reinstating the pavements disturbed, and charge the company the actual cost, with an addition of 10 per cent. The bills for these street openings are made out and paid weekly, and the Corporation, under the provisions of the order, hold in reserve £500 of the company's money. This sum has always to be maintained as a deposit for the protection of the Corporation.

The company charge for the electric light the following—viz.: For the first 100 hours (per quarter) at the rate of 1s. per Board of Trade unit; between 100 and 200 hours at the rate of 8d. per Board of Trade unit; any number of hours over 200 at the rate of 4d. per Board of Trade unit.

The underground wires for electric lighting are now being laid in the thoroughfares of the city. The method adopted is to place the tube containing the wires in a cast-iron casing, with sockets (somewhat resembling a square rain-water pipe cut in two parts longitudinally), this trough being then filled with bitumen, and finally covered on top with cement, forms the complete arrangement for protecting the cables. The new electric mains and cables have not been yet brought into requisition, and up to the present time there is no public electric lighting in Liverpool. The system will be all high tension, reduced in the ordinary way by transformers. Siemens dynamos and Willans steam-engines are used in the several stations in the city. The average annual period of public lighting by gas is 4,000 hours, and the price is from 2s. 9d. to 3s. per 1,000 cubic feet.

BRADFORD.

The gas works in Bradford are the property of the Corporation, which engages to deliver 15-candle gas to the consumers, but in reality the standard of supply is maintained at 18 c.p. Prior to the Corporation acquiring the works, the price of gas was 4s. per 1,000ft.; it is now reduced to 2s. 3d. Besides this substantial benefit to the consumers, considerable profits have been realised for the benefit of the town, amounting to £30,000 in the first year, whilst the price of gas was 4s. per 1,000 cubic feet; and £17,000 last year, when gas was 2s. 3d., with the still further advantage of having the entire municipal and public lighting altogether free of cost. The purchase of the gas works cost the town £210,000, the money being borrowed at 4½ per cent., and this rate has since been reduced to 3½ per cent. The old Bradford loans will be paid off in 100 years, and the more recent gas works loan will only commence to be repaid when the former loan is paid off. The Corporation allows a discount of 2½ per cent. on all gas accounts from £1 to £15; from £15 to £30, 5 per cent.; from £30 to £45, 7½ per cent.; from £45 to £60, 10 per cent.; £60 and upwards 12½ per cent.

The Corporation, under a provisional order, is about to distribute the electric current for domestic lighting, motive power, and other purposes. It is not intended to introduce public electric lighting under the scheme until it is ascertained to what extent the public will avail themselves of the electric supply, and also in consequence of the great success of the gas undertaking. The new light is at present intended for the illumination of houses and buildings in the central portions of the town. The necessary works are estimated to cost £24,000. The Corporation proposes to supply the light at a charge of 5l. per Board of Trade unit.

In regard to machinery and plant, the central station, which is very nearly finished, contains three Siemens dynamos, each of 600 amperes and 150 volts; two engines by Willans and Robinson, and one by Marshall, Sons, and Co., each of 150 h.p. indicated; three steel boilers by Holdsworth and Sons, of Bradford (Lancashire type), 7ft. diameter, 28ft. in length, having two flues, and fitted with Galloway tubes, etc. These boilers work up to 140lb. per square inch, and have Worthington feed pumps attached to them. The chimney is of 5ft. 6in. uniform internal diameter throughout, and is 103ft. in height. The engine-room, 60ft. by 21ft., contains a travelling gantry. There are at present four regulators to indicate the tension at corresponding "feeding" points in the town, and by means of these, the current, which it is intended to deliver in the houses at low tension, can be controlled and increased, both in quantity and in pressure, as required.

Eight and a half miles of electric mains have been laid, the wires being encased in lead pipe, with an outer covering of tarred jute. The cables are simply laid in the ground, generally under the pavement, save in certain places across passages and roads, where small brick

culverts are constructed as an additional means of protection for the mains from the heavy traffic.

The Bradford Corporation will work the installation, and supply all the electric current, similarly as it does with the gas supply, and will not allow any company or contractor to get any powers in regard to electric lighting.

It should be noted that the above supply of electricity is on the "continuous-current" system, and adapted therefore to the supply, not merely of lighting but also of motive power, the use of storage batteries, the deposition of metals, and other numerous industrial applications of the electric current, whilst still retaining the power of using "high pressure" when required in the "carrying mains" for transmitting the current to a distance.

After investigation of the various systems of town's supply, the Corporation decided in favour of the above "continuous-current" system as against that of "alternating currents at high pressure," which they state is not adapted to many of the above-named applications.

LEEDS.

The Corporation of Leeds own the gas works, and they supply gas to the public at the price of 1s. 10d. per 1,000ft. As regards this low price, your sub-committee were informed that the policy of the Gas Committee, as representing the Town Council of Leeds, has always been to supply gas to the ratepayers at a price as near as possible to that of production, whereas in many other municipalities the practice appears to have been to supply gas at such a price as would enable the authorities to realise a considerable profit, such profit being paid into the corporate exchequer, and applied in reduction of the annual rates levied throughout the district to meet the expenditure of the several corporate departments.

So far as Leeds is concerned the price of 1s. 10d. per 1,000ft. charged to consumers during the past few years has not enabled the committee to hand over any considerable profit, the reason being the great reduction in the prices realised by the committee for the residual products, but as appearances now tend towards the probability of an increase in the prices for residual products, the committee anticipate an early realisation of increased profits from this source.

The Corporation of Leeds have been engaged in carrying out experimental works in electric lighting since May, 1883, and at a meeting of the Town Council, held on the 3rd July, the Electric Lighting Committee of the Corporation presented a report to the Council giving a review of the proceedings of the committee since its formation in 1882, and also the particulars of a scheme for lighting the town from a central station.

In their report to the Council, the committee state that "The foundation of success in all the places visited is based on the use of a much higher potential than that heretofore used in England. From the facts stated, the Council will see that the electric lighting of wide areas from central stations, and at a reasonable tariff, has at last been accomplished. Having come to this conclusion, your committee decided to consider the details of such a scheme for Leeds, and report the same to the Council.

"Before proceeding to these details, however, it has to point out that whilst the alternating high potential current system has achieved so much, it cannot at present supply electrical energy capable of use for motors; although within the last few days discoveries have been made in this respect which make your committee hopeful that in a very short time this drawback will be removed.

"A further point to which allusion should be made is, that the electric current used in the installations just described and approved by your committee is an alternating one, whilst (for the reason previously set forth in this report) your committee's existing installations have been put in on the continuous-current system. This change of opinion is the result of seeing alternating installations actually in work, and the knowledge obtained that the alternating high potential current has (by reason of the use of transformers to lower the potential for safely running the lamps, by the great improvements made in insulation, and by the adoption of more perfect modes of laying the cables and services) become practicable and sufficiently safe for general use.

"In regard to street lighting your committee reports that whilst incandescent lamps have proved a complete failure, should the Council, at any time, think fit to light the streets of this district with arc lamps, the system here dealt with readily permits of the same, as the power required is only equal to 4,000 incandescent lamps, which number is included in the total 37,500. From this fact, too, the Council will understand that this system permits customers to use either arc lights or incandescent lamps, or a combination of both. As in practice it is found that only two-thirds of the number of lamps in an electrical installation will be burning at one time, engines and dynamos for the installation proposed need only be sufficient for 25,000 lamps. The horse-power required for this number of incandescent lamps would be about 1,700 indicated. The lamps in this scheme are taken nominally at 10 c.p., but they will, no doubt, be burned somewhat higher than that. This candle-power has been taken, because in London it is found equivalent in power to the gas-burner generally used.

"As to the leads or wires, the question of overhead v. underground wires has been very much discussed, more especially, perhaps, in America, with the result that the system of underground wires in iron pipes is adopted as the best. The considerations which led to this conclusion were the reduced risk of personal danger; the greater ease of making connections or repairs; and the removal of the un-ightly appearance which the large electric wires and their supports presented. This matter, however, is now regulated by the Board of Trade; and of such importance does the Board at present deem this mode of laying that it makes it a condition in its orders. Further, in the report just made by Major Marindin on the applications for

provisional orders and licenses for lighting many of the districts of London, he recommends 'That wherever the company now supplying a district by means of overhead wires is granted an order . . . it should be placed under the obligation to remove these overhead wires within a period of two years from the granting of the order.' At Eastbourne this plan has stood the test of seven years' experiment most satisfactorily. For all these reasons the committee recommends that all wires should be placed in proper channels underground.

"Your committee has obtained tenders from several of the most successful electric lighting companies for carrying out the lighting of the districts previously described. These tenders include buildings and machinery erected so as to admit of extension, chimney-shaft, and all costs of providing and fixing cables, transformers, and meters; in short, the total cost of the installation for 37,500 10-c.p. lamps complete, leaving each customer, however, to pay for fitting up his own premises and connecting to the mains, as in the case of an ordinary gas supply. Averaging these tenders, and adding the value of land and other necessities not included in the tenders, together with 5 per cent. for contingencies, the total cost amounts to the sum of £58,000.

"Whilst there can be no doubt as to the suitability of the district chosen, your committee would point out that, from the nature of the business of that district, a large demand for the light will not extend far into the evening, and that, consequently, the initial or extra cost of getting up steam and maintaining it during the hours of small demand will make the cost of production more than if, in addition to the district chosen, there could be added a considerable number of private residences which would take up the demand as places of business and shops ceased. This feature could be added to the scheme already described by laying down mains to residential portions of the borough. This would cost an additional £10,000, making with the £58,000 required for the central town scheme £68,000.

"The charge made by the leading London companies upon their customers works out to one farthing per hour per 10-c.p. lamp, and this, of course, includes their profits.

"Your committee's experience on this head is that the nett cost of the 16-c.p. lamp (the size used in the existing installation) is only one farthing per lamp per hour. Looking at the smallness of this installation, compared with a large central lighting station for the town, the committee is of opinion that an incandescent 10-c.p. lamp can, after paying for depreciation and interest, but not making a profit, be run for $\frac{1}{2}$ of a penny per lamp per hour."

The conclusions and recommendations of the committee are as follow: "1st. That it is desirable to keep the control in its own hands of what may prove eventually a very important business, deeply affecting the duties and responsibilities of the Council. 2nd. That the committee can undertake electric lighting at a cost to the consumers of say $\frac{1}{2}$ of a penny per lamp per hour, whilst a company could only do so at a cost to the customer of double that price, i.e., $\frac{1}{2}$ of a penny per lamp per hour. 3rd. That should a company undertake the lighting, any saving in the cost of production would not at once benefit the consumers, as it would only be given at the termination of periods of rest of probably seven years. 4th. That as a company, under the Act of Parliament, would have powers lasting 42 years, it is not desirable to give such company possession of the streets of the borough for so long a term, and with statutory powers which would interfere with any other new service requiring the use of the streets. The Council has already had experience of this in regard to the tramway company and the late gas company. 5th. That although it is competent for the Council under the Act of Parliament to agree with a company for a shorter term than 42 years, this can only be done by granting compensating advantages to the company."

Finally the committee resolved: "1st. That the report now read be adopted, and a copy forwarded to each member of the Council. 2nd. That the Council be recommended to light by electricity such portions of the Town Hall and Municipal Buildings as are described in the report, at an estimated expenditure of £3,000. 3rd. That the Council apply to the Board of Trade for a provisional order under the authority of the Electric Lighting Acts, 1882 and 1888, authorising the Corporation as the local authority under the Acts, to provide and supply electricity for public and private lighting purposes within the area referred to in the report, at an estimated total capital expenditure of £68,000, and that the town clerk (in conjunction with the Electric Lighting Committee) be authorised and empowered to take all necessary legal and other proceedings, and to give all notices on behalf of the Council which may be necessary in connection with the application to the Board for and obtaining such provisional order. 4th. That the Council authorise the Electric Lighting Committee to carry out and complete an initial installation of electric lighting within the district mentioned in the report at an estimated capital expenditure of £25,000, such sum being part of the sum of £68,000 to be borrowed under the authority of the provisional order. The Council adopted the recommendation No. 2, but the recommendations Nos. 3 and 4 were referred back to the Electric Lighting Committee for further particulars, and as to the cost in other towns where the electric light has been adopted."

Extract from an article in the *Leeds Evening Express* of July 4, 1889, referring to the Proceedings of the Municipal Council on the Subject of Electric Lighting.—"Something was said yesterday about the price of the light. The committee, we see, state that the price would be equal to the price of gas at 3s. 5d. per 1,000 feet. But when the benefits derived in other ways are considered, few, we imagine, would consider that this was not as cheap as, or cheaper, in proportion, than gas. The advantages to health and property would be solid and extensive. The risk of explosion, or of fire from window-hangings getting over gas globes, would be completely avoided, and we should escape the heat and fumes of gas. One jet of gas in a room consumes as much oxygen as five persons. The electric light con-

sumes none, but is extinguished if oxygen reaches it. Gas injures bookbindings, furniture, etc., the electric light does not. Draughts do not affect it, and it is easily lighted and extinguished without the need of tapers, or lucifers, which are often an annoyance in the case of gas. The advantages it offers, in point of convenience, comfort, and health are altogether enormous; and realising those advantages, we trust the Council will determine to make them available for the town instead of allowing any outside body to do so."

SHEFFIELD.

The Sheffield Telephone Exchange and Electric Light Company, Limited, with a capital of £60,000, has installed the only system of electric lighting in Sheffield, but without any special powers or authority to light the town. The Corporation did not oppose the company or promote any scheme of electric lighting on its own behalf. The Thomson-Houston system is used for arc lights at high tension. There are three dynamos for producing a total of 150 arc lights each of 2,000 c.p., and each dynamo works up to 2,000 volts. These machines were made in America, and each of them requires 40 h.p. in the working. There is also a Mordey alternator dynamo, made by the Brush Electric Light Corporation, capable of working day and night for 600 to 700 incandescent lights. This dynamo at present produces the 200 incandescent lights of 16 c.p. now in use. Orders have been received for all the lights that the present machinery can produce, and more appliances will be laid down forthwith. The engine is by Tasker, Sons, and Co., and has a Galloway boiler in connection with it. The charges are: For one arc lamp £20 per annum (equal to a penny and a fraction per hour); two ditto, £35; three ditto, £50. Incandescent lamps, 25s. for each lamp of 16 c.p., and the transformers for incandescent lighting are fixed on the consumer's premises. The works produce 150 arc lights of 2,000 c.p. nominal, with actual light of 1,000 candles through the opal globes. Incandescent lighting only admits of comparison with gas in regard to cost. The company in Sheffield asserts that it can manufacture and supply electric light with profits equal to what would be gained from gas at 4s. per 1,000ft. For public lighting the company's secretary recommends the arc system as the cheaper. The incandescent light for street illumination is not at all so satisfactory, and in that respect has proved unsuccessful at Holborn Viaduct, Leamington, and Barnet.

The company's undertaking in Sheffield yields a dividend of $7\frac{1}{2}$ per cent., and in addition a large reserve fund has been created, but the company carries on a large telephone exchange business in addition to the electric light. The charges for gas in Sheffield are regulated according to scale—viz., 2s. 4d. per 1,000ft. to ordinary consumers, but for large supplies up to 500,000ft. 2s. 2d. per 1,000ft. is charged, and 2s. between 500,000ft. and 6,000,000ft., and 1s. 10d. per 1,000 cubic feet for any greater quantity. The price paid for public lighting by gas is 1s. 10d. per 1,000 cubic feet. The gas in Sheffield is in the hands of a company, which pays a good dividend. Three aldermen of the Corporation are entitled to and do act on the board of the company, and vote in the ordinary way.

EASTBOURNE.

The electric light was introduced in September, 1882, by a local company, with a share capital paid up of £12,500, recently increased by some £5,000 debenture stock. The company, of which the mayor, Mr. Boulton, is chairman, began operations on the series system of lighting, but found it advisable to alter the works to the alternating or parallel transformer system instead. As a result, it is hoped that the company will be in a position to realise a profit, notwithstanding the increased price of coal from 19s. to 25s. 6d. per ton. The water for steam power costs the company 1s. per 1,000 gallons. The wires conveying the currents are all underground, and the public lighting system is entirely separate and apart from the private supply. In all there are 2,300 incandescent and 21 arc lights, for which the following charges are made: Incandescent Lights.—1s. per unit for first 100 hours in quarter; 8d. for second hundred hours; 4d. for any greater number. Arc Lights.—The Corporation pay the company £30 per annum for each arc light. The price had been £35, subsequently £25, but now £30.

The Town Hall is beautifully lighted with the Edison-Swan incandescent loop light. The Lowrie-Hall system is used for incandescent light for ordinary purposes. Private incandescent lamps are supposed to work about 1,000 hours, the filament then breaking. The glass globe gradually becomes blackened with long use. There are 17 arc lamps of the Brush system on the esplanade, erected on poles 20ft. high and 300ft. apart. As they are of an old design, the light from them is somewhat flickering and unsteady. These, as well as three other arc lamps, which are fixed in the markets, give a light of 1,500 c.p. nominal.

The company uses one compound engine (Fowler) of 200 h.p., and two dynamos (Lowrie-Parker) with a capacity of 50 and 70 units respectively. This is sufficient to supply 2,000 16-c.p. lamps alight at one time. The steam for the engine is supplied from a tubular boiler of the locomotive type working at 140lb. pressure per square inch. The Lowrie-Parker dynamo has revolving magnets with fixed armatures, whereas the Ferranti machine has revolving armatures and fixed magnets. The former works with low tension on the brushes, and is free from danger to workmen, and all the high-tension parts of the machine are cased round up to the leads as a safeguard against accident. The dynamo in use cost £400, and delivers an energy of 70,000 watts. Lowrie-Hall transformers are used, converting the high tension of 2,000 volts to a safe working potential of 100 volts. A fuse is attached to each lamp for the purpose of disconnecting the current in case of accident. Formerly the company employed three boilers for three Brush machines, but now have but one boiler to work the Brush machine, which generates a continuous current for the arc light supply. The cables are 7ths (or seven strands of 16 gauge), and are laid underground in 3in. gaspipes. The wires are enclosed

in three layers of indiarubber, with an outer covering of stout braiding.

The manager of the Queen's Hotel informed us that he considers electric light is not more expensive than gas, over which it has many incidental important advantages—viz., coolness, cleanliness, and comfort to visitors, as well as the saving effected in the cost of decorating ceilings, etc., which has been rendered unnecessary for the past three years the light has been in use. The owners of other establishments were equally favourably impressed with the change from gas to electric lighting. The present price of Welsh coal in Eastbourne is 25s. 6d. per ton. Gas supplied to private consumers costs 3s. 7d. per 1,000 feet, and the charge for public lighting is at a somewhat lower rate.

HASTINGS.

Electric light has been installed by a company with a nominal capital of £50,000, of which about £14,000 is issued, the object in view being to keep pace with other watering-places in the matter of improvements. The cost of production and supply is slightly in excess of gas, and the company, which pays a dividend of 3 per cent. on the undertaking, is now negotiating to transfer the work to the local authority.

The company supplies 1,000 Edison and Swan incandescent lights, to hotels and other places, of from 8 to 10 c.p. each, and 30 Brush arc lights, each of 2,000 candles nominal. For the latter the company is paid £30 each per annum. Ten amperes to the arc is the greatest current used, and the cables are sufficiently strong for seven times greater power. There are 20 miles of underground wire in Hastings, the cables being $\frac{1}{2}$ in. strand, cased in gutta-percha, with other material for outer covering. The factory and workshops, built at a cost of £4,000, are of three storeys, the upper storey being set apart for workmen's dwellings. The machinery includes five Brush dynamos, each capable of producing 40 arc or 500 incandescent lights; two 40 h.p. Robey boilers and engines, one of which is sufficient for the work, and one large multitubular steel boiler, 7'6 by 26, of 100 h.p., by Duncan, Stewart, and Co., Glasgow. Note.—Three dynamos of the Elwell-Parker type can be worked upon one cable, and all will "keep step," or synchronise.

The scale of charges for electric light in Hastings is as follows: Cost of installation (not including brackets), one group of eight lamps, £5; each succeeding group, £4; supplying light from sunset to 11 p.m., £2 per lamp per annum; supplying light from sunset to 8 p.m., £1.10s. per lamp per annum. If supplied by company's meter, $\frac{1}{4}$ d. per lamp per hour: Installation for one arc lamp, £5; lighting for one arc lamp, £30 per annum. The company will lay mains to consumers' premises. Coal is brought to Hastings by rail from Yorkshire via London, and costs 18s. 10d. per ton, with the addition of 2s. 6d. for town dues, making in all 21s. 4d. per ton. The charge for gas is 3s. 4d. per 1,000 feet. The County Council of Hastings are under a contract with the company as to lighting the front-line at £30 per light per annum for each arc lamp. The system of underground wiring is strongly advocated, thereby saving a very large amount of labour and expense in erecting, maintaining, and rentals.

ROCHESTER.

In Rochester, electric lighting is carried on very successfully by a local company, which is working at the present time without statutory powers, but the necessary steps are now being taken to obtain a provisional order. The system employed is that of high-tension alternating currents (2,400 volts) in conjunction with transformers, the principal advantages of which are: 1. The cables constituting the main circuits are kept very small in sectional area in proportion to the large amount of electrical energy conveyed, and, consequently, the cost of mains, which always form a very heavy item, is kept within moderate bounds. 2. It is possible to run at the same time, on the same circuit, lamps of different makers and various voltages, whether they be arc or incandescent.

The plant now at work is at present supplying what is equivalent to about 3,000 lamps of 10 c.p. each, but it is sufficient for 4,000 lamps of like power, and has cost £13,000, which includes three items of extraordinary expenditure, as follows: 1. £1,500 for sinking and boring an artesian well 339ft. deep, which affords a constant supply of water at the rate of 30,000 gallons per hour. The water is used for condensing and other purposes; great economy in working being thereby effected, as there is a saving in fuel to the extent of nearly 50 per cent. 2. £1,000 for engine and dynamo foundations, which had to be made in a very substantial manner. The station is erected in a very convenient situation on a wharf, on the river Medway, where coal, etc., are readily landed, but where the sub-soil to a depth of 50ft. consists of nothing but river mud, through which wooden piles had to be driven into the solid chalk below to support a solid block of concrete 18ft. in thickness. 3. £2,000 for lamps, wires, and other miscellaneous stores required for installing the light in public and private buildings, clubs, shops, dwelling-houses, etc. The company doing the whole of the fitting work themselves. The mains are carried overhead on poles, there being two circuits, each about two miles in length.

At the present time the company have no portion of their plant in duplicate. Everything runs extremely smooth and well; there has not been a single breakdown, hitch, or slightest irregularity in the supply of current, which commenced in the early part of last November. The dynamo was supplied by Mr. S. Z. de Ferranti, of London, and is of the 1888 type: 150 e.h.p., and cost £1,050. The engine employed is of the horizontal type, surface condensing, 4ft. stroke, it is fitted with Spencer and Inglis's patent Corliss valve gear, and Knowle's patent supplementary governors, which give great satisfaction. The driving-wheel is 20ft. in diameter, cotton ropes being employed for gearing. There is a small patent barring engine for turning the large engine slowly. The engines were made and supplied by Messrs. Hicks, Hargreaves, and Co., of Bolton. The Babcock

and Wilcox Company, of London and Glasgow, supplied the boiler, which is of their well-known water tube pattern. Later on it is intended to employ the foregoing plant for day work only. Steps are already being taken for laying down plant four times the size of that already installed. The uniform charge for current supplied is 6d. per Board of Trade unit. The anticipated income for this year from the lamps at the present time supplied is £2,500, which is calculated to yield 11 per cent. dividend on the invested capital, after a liberal allowance for depreciation on plant has been made. It should, however, be borne in mind that working expenses are kept very low, one man alone, for example, attending to boiler, engine, and dynamo. The charge for gas at Rochester is 2s. 3d. per 1,000 cubic feet.

KENSINGTON.

The Kensington central electric lighting station, adjoining the West Brompton Station of the Metropolitan District Railway, was opened on January 24, 1889, by the House-to-House Electric Light Supply Company, Limited, which has expended about £35,000 on plant and works, and expects to realise a substantial profit from the undertaking. The buildings are most admirably designed, and are constructed with a view of extension in the future.

The plant installed is on the Lowrie-Hall system, and is divided into three units. Each unit consists of 150 e.h.p., each capable of producing electricity for 4,000 lights, and in order to always have a margin of power in case of break down, the maximum work done by the station will be the supply of electricity for 8,000 incandescent lamps. In case, therefore, of any one unit having to stop when the full load is on, the remaining two will be able to easily carry on the work. In connection with this plant 12,000 lamps may freely be let out, wiring in the houses on the circuit being done for this quantity, as in practice it is found that never more than two-thirds of the total number of lamps wired for are in use at one time. The company give the consumers the privilege of declaring a maximum supply demand, and they find that where say 50 lights are installed, the maximum supply demand seldom exceeds 30 lights, the consumer paying on the basis of this number, each customer having fitted to his installation a meter on the reading of which the charge for electricity is based. A ten ton travelling crane spans across the engine-shed, capable of expeditiously moving an entire dynamo or any other part of the machinery. The main switchboard is arranged for three circuits and three dynamos, to enable any circuit to be put to any dynamo while running separately or in parallel, with three current meters, three voltmeters, and three synchronising boards, also efficient safety fuses. The pressure or voltage of electricity is kept constant at the terminals by a very ingenious automatic E.M.F. regulator. The floors around engines and clear spaces are Staffordshire blue chequered bricks with blue brick edgings. The boiler-house floor is granite cement; all pipe and wire trenches are covered with wrought-iron chequered plates. The floor around dynamos is highly insulated of double seasoned pine, fastened down with wood pegs and covered with linoleum.

It is stated that by this system of sub-dividing into units of 150 e.h.p. the gradually increasing load that occurs in the early hours of lighting is economically dealt with. At the time of the lightest load, when one unit could do the whole work, there would be only two units working (i.e., it and its reserves), and as by this system they could both be working on the same circuit in parallel—that is, the whole of the dynamo machines electrically connected—so that if from any cause one of the machines ceased working, the load would instantly be equally divided between the others without stoppage of the lighting on any of the circuits, and they would both be working economically and safely. As the demand gradually increased, one unit after the other would be thrown on to the circuit with the same economical results, and with the same safety against breakdown. The use of 150 e.h.p. units will allow of extension to 12 units, as proposed, always with the most economical results. Each unit consists of a special compound horizontal coupled non-condensing engine, fitted with automatic expansion gear on both cylinders and heavy flywheel pulley, grooved for driving by ropes. Three special water tube boilers. Working pressure 150lb. per square inch, with necessary pumps and water heaters. Three special alternating-current dynamos, with exciter to each.

LONDON.

While in London your committee inspected the works of Mr. Sebastian Ziani de Ferranti, the distinguished electrical engineer, at Charterhouse-square. Here the manufacture of all descriptions of electrical appliances—many the inventions of Mr. Ferranti—is in operation on an extensive scale. One dynamo working up to 2,400 volts, driven by an engine of 150 h.p., was taken asunder, portion of the armature removed, replaced, and the machinery again put in motion in a few minutes. This rapid taking apart of the machine and the ease with which coils can be replaced are rightly considered by the inventor to be two of its most valuable features. A dynamo sufficient for 200 lights can be supplied for £85, but as the smallest size machine Mr. Ferranti stocks is for 3,000 lights, machines for a less number of lights would have to be specially made to order. Mr. Ferranti is engineer to the London Electric Supply Corporation, the undertakings of which at the Grosvenor Gallery and at Deptford are now subjects of much attention.

THE GROSVENOR GALLERY—CENTRAL ELECTRIC LIGHT STATION.

The following description of this successful and most interesting installation, which supplies from 30,000 to 38,000 lights, is in part taken from *Industries*: As far as the station itself is concerned, the most interesting parts of the plant are the two large Ferranti dynamos. The first of these machines was set to work in the spring of 1887, and the second machine was running within a year of the time when the work of changing over to the Ferranti system was first taken in hand. The machine, as now made, differs from the original

low-tension Ferranti dynamo, inasmuch as the armature-conductor does not form a continuous strip of zig-zag shape, but is arranged in separate bobbins, somewhat after the manner of a Siemens armature. The bobbins are formed of corrugated copper strip (by means of which a very rigid construction of armature is secured without necessitating a departure from the requirements of a perfect dynamo, i.e., very little width of conductor in an intense field) wound over a core of brass and asbestos, a strip of fibre insulation being wound in at the same time so as to separate the convolution. One end of the copper wire is connected with the brass core which thus forms one terminal, and the other is so arranged that the act of putting the bobbin into the armature makes a connection with the proper terminal of the bobbin next to it, so that it is quite impossible to make a false connection. In the new machines the bobbins are connected in pairs, and after being put into position, the insertion of the studs which hold the bobbins in position make the connection. The bobbins can be replaced by a workman of ordinary intelligence. The bobbins in the machine at the Grosvenor Gallery are held in a metal ring, by means of iron clamps and ebonite insulation; but in the latest form of machine an improved method of supporting the bobbins has been adopted. When it is considered that the circumferential velocity of these bobbins is over 6,000 ft. per minute, when the strain due to centrifugal force is about 90 times the weight, and that each is absorbing about 16 h.p., it will be seen that the insulated fastening of these bobbins presents considerable mechanical difficulties. These have been successfully overcome by an exceedingly ingenious device; but on account of the foreign patents we are not yet at liberty to publish it. There are in each machine 40 bobbins, 20 on each side of a polar diameter being coupled on series, and the two halves of the armature in parallel. By this means the difference of potential between neighbouring bobbins is reduced to 120 volts. There are 20 bobbins in series, and the greatest tension at any one point between two bobbins is 240 volts. The cores of the magnets, of which there are 40 on each side of the armature, are of wrought iron, and the yoke rings are of cast iron. In casting the yokes the magnets are placed into the mould, and the metal is run round them, thus making the very simplest possible attachment, and ensuring a high degree of magnetic conductivity at the joints. The armature is overhung upon a shaft, which is enclosed in bearings for nearly its whole length, and the magnets are so arranged on the bedplate that they can slide back in a direction at right angles to the shaft, so that the armature may be easily inspected and cleaned. To open out the field it is only necessary to slacken a few bolts and draw back the two halves of the field by hand levers which are provided for the purpose, the whole operation taking only a few minutes. The large machines intended for Deptford will also be provided with field-magnet frames, which can be opened out, but in this case the separation of the two halves will be in a plane at right angles to the centre line of the shaft, and a separate little steam-engine will be used to draw the fields apart and push them together again.

The following table gives the principal data of the latest form of Ferranti machine designed for an output of 625 e.h.p.: Mean diameter of armature, 7 ft.; speed, 275 revolutions per minute; surface speed, 6,050 ft. per minute; section of armature strip, 12.5 by 0.75 mm., wound double with insulation between; number of turns in each bobbin, 25; number of bobbins, 40; connection, 2 in parallel, 20 in series; E.M.F. 2,400 volts; M.F. per bobbin, 120 volts; volts per foot of active strip, 3.0; interpolar space, $\frac{1}{8}$ in; insulation, 0.5 mm. and 0.125 mm.; current, 194 amperes; output, 465 kilowatts; resistance of armature, 0.176 ohm. Field-magnets—number of bobbins, 80; volts, 86; amperes, 104; exciting energy, 12 h.p. = 1.9 per cent. of output.

The equipment of the station with scientific instruments is of a very simple character. There are two current measuring instruments, one ampere balance, and one ampere gauge. The ampere gauge is kept for engine-room work, the balance for purpose of exact measurement. The pressure is indicated by a Cardew voltmeter, connected to the secondary of a small pilot transformer, the man in charge simply regulating the speed of the engine, so that the pointer of the voltmeter stands at a fixed mark. The resistance of the main circuits is so low that there is no necessity for varying the pressure kept at the station, and all the five circuits are fed at exactly the same pressure.

The distribution is effected by about 100 miles of $\frac{1}{2}$ cable, with specially heavy insulation. The cable is arranged in five circuits, and is carried over the housetops, street crossings being invariably arranged at right angles so as to limit the length of the crossing spans. The cable is supported by leather thongs from a steel wire, which is itself stretched between insulators fixed on wrought-iron poles. The out and home circuits are carried one above the other by the same poles. Each of the five circuits is protected by tinned copper wire fuses in both branches. The terminals of the fuses are provided with long ebonite handles, and can be quickly replaced, for which purpose a number of fuses are kept ready to hand on a rack below the row of fuses in use. The fuses are about 2 ft. long, and consist each of a number of thin wires so arranged as to keep apart, so that the rate of heat radiation may be a definite quantity. The wires are placed into a slot, formed by slate bars with semi-circular notches. The slate is not used as an insulator, but simply to prevent the fuse from being accidentally touched, to cool it, and to chill out the spark should the fuse go. Both branches of the house services are also protected by similar fuses, but instead of being embedded in slate, they are embedded in earthenware. The service wires are run through separate porcelain tubes, and are provided with double-pole switches. The fuses are placed between the switches and transformers, and the man charged with renewing a fuse has instructions to switch off the current before removing the old and inserting the new fuse. The transformers are, where possible, so placed as to be inaccessible to the inmates of the house, and the terminals for the

attachment of the primary leads are so arranged as to require a specially long screwdriver to reach them. One hundred and twenty of the subscribers are supplied by meter, Ferranti meters being used. The first of these meters was installed in September, 1887, and is still in use. In the latest form of meter a very simple device has been adopted for correcting the mechanical error due to initial friction.

In the Ferranti meter the current passes through a mass of quicksilver held in a cylindrical cavity, which is placed in a magnetic field, produced by the current to be measured. Under the influence of the field, and a current passing from the circumference of the little quicksilver lake to its centre, or *vice versa*, the quicksilver is set into rotation. The resistance to rotation owing to friction is approximately proportional to the square of the speed, and as the turning moment exerted by the current is proportional to the product of strength of field and current—that is to say, to the square of the current—the number of revolutions performed by any particle of mercury in a given time can be taken as a measure for the quantity of electricity which has passed through the meter in that time. The measurement would be absolutely correct were it not for the fact that the resistance of a liquid does not perfectly follow the law above mentioned, and that the clockwork by which the rotation of the mercury is recorded has some friction of its own, which is almost a constant, and must introduce a sensible error when the propelling force is small, that is to say, when but little current passes through the meter. To correct this mechanical error, Mr. Ferranti introduces a magnetic error by making the field not strictly proportional to the current. He employs a shunt coil, which gives to the field an initial value, independently of the current to be measured, and thus an excess of electromagnetic action is secured at the very time when there is an excess of frictional resistance as compared with the frictional resistance of the mercury. Since the current is an alternating one, it is necessary to introduce into the circuit of this shunt coil a comparatively large non-inductive resistance, in order that the current wave in the shunt coil may in point of time approximately coincide with the wave of current through the main coil. By the means here briefly alluded to, it has been found possible to make the meters read correctly down to $\frac{1}{100}$ th of their full capacity, and it is not too much to say that this addition to meters of a simple compound winding has solved a very difficult problem in electric light distribution—viz., the production of a perfectly accurate meter. The amount of energy absorbed in the Ferranti meter is very small, the fall of potential across its terminals is imperceptible.

There are at present over 280 customers supplied from the Grosvenor Gallery central station, taking collectively about 1,400 h.p. of electrical energy. This gives an average of 5 h.p. for each installation, which is rather more than might be expected in purely residential districts. This high average is probably due to the fact that many of the subscribers are exceptionally large consumers (theatres, restaurants, etc.), and that the minimum charge made by the London Electric Supply Corporation, no matter how small the number of lights installed, is £20 per annum, which is likely to act as a deterrent to very small consumers. The present charge for current is at the rate of 74d. per Board of Trade unit, and the pressure is on the mains night and day throughout the week, from 10 o'clock on Sunday morning till 3 a.m. on the following Sunday. Thus the only time when the whole of the machinery is at rest is seven hours (3 a.m. to 10 a.m.) on each Sunday.

The opponents of the system pointed out that a large steam dynamo must work most of the time very much under-loaded—that is, in a condition which does not permit of the economical use of steam in a compound engine. With the arrangements adopted at the Grosvenor Gallery this objection falls to the ground, as the load is so divided and distributed among the various engines as to enable them to work at nearly always their most economical load. The power supplied to the dynamo is never less than that which can be economically exerted by one of the engines, or say about one-fifth of the output of the station at 6 p.m.; even in the small hours of the morning the supply of current represents about 150 e.h.p., or say over 200 i.h.p., and this amount is sufficiently large for economical working if only one engine is used. The efficiency of the Ferranti dynamo at the lowest is about 72 per cent. = e.h.p. at dynamo terminals = i.h.p. of engine cylinder. As the demand for current increases, the second engine is started and run up until its speed coincides with that of the other engine. At this moment the clutch coupling is thrown into gear, which can be done without the slightest shock, and the load is then divided between the two engines. Later on, in the afternoon, a third Marshall is similarly added, and when the load has increased beyond the capacity of three Marshall engines combined, a Corliss engine is started, and the load is transferred to it by means of the following simple device: There are six main circuit switches, of which five are now in use. Each of these switches controls one of the external circuits, and serves to connect them with either of the two dynamos, but not with both simultaneously. The switches are arranged to give a 4 ft. break, and although the current flows through them under a pressure of 2,400 volts, and they are used several times a day, they have as yet kept in perfect order. No repairs of any kind have been necessary, and the only attention the switches receive is a cleaning down once a week. By means of these switches one circuit after another is transferred from the dynamo driven by the Marshall engines to that driven by the Corliss engine, and the first dynamo is then stopped and cleaned down. When, later in the evening, the demand for current begins to increase beyond the capacity of the Corliss engine, one of the Marshall engines and the first dynamo is again started, and one circuit transferred back to it. The other Marshall engines are successively started, and one or two more circuits switched over; so that during the hours of heavy lighting all the four engines and both dynamos are in full work.

The maximum power which in a transfer is suddenly taken off one and thrown upon the other dynamo does not exceed 300 h.p. The time interval between switching off a circuit from one machine and switching it on to the other is so short that the lamps on that circuit have not time to become completely black. Before the filament has cooled, the current from the other machine is already flowing; and thus the customers only notice a momentary blink in the lamps at the time of switching over. In this manner it is possible to work always with nearly maximum economy, notwithstanding the fact that the output of the station varies within wide limits. As regards the amount of variation, the reason for the comparatively even demand for current during 24 hours is that the current is supplied not to one particular class of houses, but to a great variety. Amongst the customers are shops, theatres, clubs, restaurants, private houses, printing offices, etc. These different customers do not require their maximum supply all at the same time, but at widely different hours. The shops do not take current after 7 or 8 p.m.; the theatres, on the other hand, take most current after that time. The theatres go off between eleven and midnight, but the clubs keep on till about 3 a.m. After that the current is only required in a few private houses and in printing offices, and similar establishments where work is going on all night. This overlapping of the demand from the different classes of customers is favourable to the economical supply of electricity.

This company intends to transfer its works to Deptford, where the installation, when complete, will be of great magnitude; the works are designed to supply one million lights, and will engage engines and boilers of 143,000 h.p. in the aggregate. The large engines are to be worked in conjunction with the largest battery of boilers in the world. The main building is 195 ft. long, by 135 ft. wide, and the boiler-house 195 by 66, built at the river side, so that coal is conveniently raised to the top lofts, which are set apart as a store to hold 4,000 tons. These works are provided with a large travelling crane and railway throughout. As coal costs 10s. 6d. per ton in Deptford, and 24s. 6d. in London, and Mr. Ferranti is so designing the mains as to only lose 2 per cent. of the total electric energy produced in them, it is easy to understand the importance of placing the generating station at Deptford and the use of the proposed high tension. There are at Deptford two engines of 1,500 h.p. finished, and two dynamos of 1,250 e.h.p. nearly so. Also four 10,000 h.p. dynamos and engines in course of manufacture for present buildings. The smaller engines have a travelling crane capable of lifting 25 tons over them at a height of 70 ft. from the floor level. The larger plant has a 50-ton crane. A central railway runs the whole length of ground, starting from the wharf, where there is a 50-ton crane and two 10-ton cranes, which are used for running the machinery from the wharf.

Underground Wires.—The London Electric Supply Corporation has several lengths of underground wires, cast-iron pipes being used and indiarubber cables. Some of these have been in use for two and a half years, and no faults have as yet occurred in them. Thus showing the perfect feasibility of the high-tension system.

The following are some of the installations on the Ferranti high-tension system: Nancy, 450 h.p., autumn of 1888, 10,000, 10 c.p.; Rethal, 150 h.p., autumn of 1888, 3,000, 10 c.p.; Glasgow, 150 h.p., beginning of 1889, 3,000, 10 c.p.; Rochester, 150 h.p., autumn of 1888, 3,000, 10 c.p.; Vierzon, 30 h.p., 1888, 600, 10 c.p.; Paris Exhibition, 150 h.p., 2,500, 10 c.p. In course of erection: Paris 450 h.p., Havre 600 h.p., La Plata 600 h.p., Rosario 300 h.p. at first, shortly to be increased to 900 h.p.

PROVISIONAL PATENTS, 1889.

SEPTEMBER 2.

13795. **For an invention—To turn artificial and natural light, even plane atmospheric light, into an electrical current.** Paul von Knobloch, 94, Wellington-street, Sheffield.
13800. **Improved supports of secondary batteries.** Georg Eduard Heyl, 8, Salzuffer, Charlottenburg, near Berlin, Germany. (Complete specification.)
13818. **Improvements in secondary batteries.** Victor Hugo Ernst, 321, High Holborn, London. (Date applied for under Patents Act, 1883, section 103, 12th February, 1889, being date of application in the United States.) (Complete specification.)
13832. **Improvements in insulators for supporting electric telegraph wires or the like.** Joshua Thomas Greenwood, 6, Lord-street, Liverpool.
13834. **Improved means and apparatus for producing electricity for electric lighting and other purposes.** William Boggett, 34, Southampton-buildings, London.
13838. **Improvements in means or devices for use in the distribution of electrical currents.** Arthur West Heaviside and Robert Cattley Jackson, 47, Lincoln's-inn-fields, London.

SEPTEMBER 3.

13941. **A new and useful telegraphone.** Malone Wheelless, 52, Chancery-lane, London. (Complete specification.)
13959. **Regulator for electric lighting.** Edward John Houghton, Camden, Underhill-road, Dulwich.
13964. **Apparatus for automatically charging secondary batteries or accumulators.** Stanley Charles Outhbert Currie, 6, Livery-street, Birmingham. (Complete specification.)

SEPTEMBER 4.

13924. **Improvements in electric incandescent lamp holders.** William Joseph Starkey Barber-Starkey, 70, Market-street, Manchester.
13955. **Improvements in transformers for continuous electric currents.** Alexander Bernstein, 4, South-street, Finsbury, London.
13956. **Improvements in the manufacture of incandescent electric lamps.** James Greenwood, 4, South-street, Finsbury, London.
13960. **Improvements in and relating to apparatus, chiefly designed for measuring electric currents.** Alfred Lyster Shepard, 45, Southampton-buildings, London.

SEPTEMBER 5.

13990. **Improvements in electro magnetic apparatus for automatically opening and closing passages for gases, liquids, and the like.** Johann Rudolf Schiller and Christian Meyer, 27, Martin's-lane, Cannon-street.
13992. **Improvements in electrical switches.** Alfred Slatter, 140, Salisbury-court, Fleet-street, London.
13993. **Improvements in electrical safety fuses.** George Edward Barker Pritchett and Henry Robert Low, Bishop's Stortford, Hertfordshire.
14011. **Improvements in switches for opening and closing electrical circuits.** Alfred Lyster Shepard, 45, Southampton-buildings, London.
14017. **Improvements in conduits for conductors of electrical energy.** Benjamin Verity, 55 and 56, Chancery-lane, London.

SEPTEMBER 6.

14047. **Improvements in electric motors.** Thomas Hugh Parker, Newbridge, Wolverhampton.
14086. **Improved means for effecting the insulation of electrical transformers, switches, switch boards, fuses, commutators, and commutator brushes.** Walter Claude Johnson and Samuel Edmund Phillips, 28, Southampton-buildings, London.
14094. **An automatic circuit-closing device for series circuits.** Albert Augustus Goldston, 4, South-street, Finsbury, London. (Complete specification.)

SEPTEMBER 7.

14113. **Improvements in switches for electrical propulsion purposes.** Moritz Immisch, 52, Chancery-lane, London.
14114. **Improved switch for electrical tramcars.** Moritz Immisch, 52, Chancery-lane, London.
14116. **Disengaging apparatus actuated by electricity.** Carl Blanke, 70, Deansgate, Manchester. (Complete specification.)
14155. **Improvements in primary batteries.** Charles Ambrose McEvoy, 24, Southampton-buildings, London.
14162. **Improvements in treating and rectification or ageing alcohol or alcoholic liquors or the like by electricity.** Auguste de Meritens, 47, Lincoln's-inn-fields, London. (Complete specification.)

SPECIFICATIONS PUBLISHED

1888.

10209. **Electric regulator.** Maquaire. 1s. 3d.
14622. **Variable adjustable resistance for electric currents.** Craven. 8d.
14932. **Electric lamps and batteries.** Maquay. 8d.

1889.

8855. **Secondary batteries.** Harris and Cameron. 6d.
9576. **Incandescent electric lamps.** Lake (Van Choate). 11d.
11328. **Electric accumulators.** Correns. 6d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.	Name	Paid.	Price Wedne day!
12 Feb. 1/2	Anglo-American Brush E.L.	—	—
12 Feb. 2/0	— fully paid	—	—
14 Nov. 0/4½	Con Telephone & Main ...	1	3
27 July 10/0	India Rubber, G. P. & Tel.	10	19½
.....	House-to-House	4½	4½
.....	Metropn Electric Supply	—	2½
.....	London Electric Supply ...	5	3½
.....	Swan United	3½	4½
12 July 12/0	Telegraph Construction ...	12	43½
2 July 6/0	— 6%, 1889	100	105
...	National Telephone	5	6½

NOTES.

Cable Broken.—A Reuter's Tangiers telegram says the cable across the Straits of Gibraltar is broken.

Ryde.—The traffic has increased so much on the electric railway at Ryde pier that a second line of rails will be laid down.

Indian Telegraphs.—A telegraph line has been opened to Mogoung, and both State and private messages are now sent over it.

Barcelona.—A new establishment, the first of its kind, has been opened in Barcelona for the sale of electric light fittings and apparatus.

Eiffel Tower.—The French administration of telegraphs have established a public telegraphic office on one of the platforms of the Eiffel Tower.

Birkenshaw.—At a public meeting at Birkenshaw the offer of the Gomersal Gas Company to supply gas at 3s. 3d. was refused. The village remains in darkness.

Aldershot.—The Aldershot Local Board has considered the application of the House-to-House Company, and are going to consult an expert after the receipt of the draft provisional order.

Edinburgh.—The Edinburgh Town Council have acquired the power to light by electricity, and refuse to sanction other schemes. The matter rests with the Lord Provost's Committee.

Gas Works Blow Up.—The meter-room of the Aldershot gas works blew up on Monday morning early. Fortunately no one was there, so no one was killed, but the walls were blown to the ground.

Lectures.—A series of twelve practical lectures on "Electric Lighting and Transmission of Power," is arranged to be given by Mr. W. B. Esson, at the Hanover-square School, commencing on October 16th, at 8 p.m.

Lighting a Nunnery.—The nuns of St. Ursula's Convent, Olmutz, will, without doubt, be the first to have the electric light introduced into such precincts. It is stated that the authorities are intending to take this step.

Telephoning to Torpedos.—Some interesting experiments have lately been undertaken at Cherbourg to ascertain the possibility of telephoning between torpedo boats and the admiral's ship, so that orders can be given direct.

Present to Technical Schools.—It is stated that Messrs. Mather and Platt have promised to give the Manchester Technical School a 100-light dynamo, for the use of the electrical engineering classes of the school.

Southport.—The Gas Committee of the Southport Corporation have resolved that an intimation be given to all parties who have given notice of their intention to apply for provisional orders to supply electricity within the borough, that the Corporation intend to withhold their consent to such applications.

Tomb Lighting.—A millionaire, who has just died at Vienna, had such an antipathy to darkness, that he has actually left instructions in his will for the illumination of his last resting-place. An electric light is to be kept burning in the vault a whole year, and even the interior of the coffin is to be electrically lighted.

Newport Pagnell.—We hear that the gas at this town is very bad and the town suffers from darkness. A favourable *coup* with electric light might possibly be done here; at any rate the attention of electrical engineers would be welcome to the inhabitants, as even the hint of a rival might wake up the suppliers of light to fresh endeavours.

Telephone in Puerto Rico.—The telephone line between the palace of the Governor-General in San Juan de Puerto Rico to the Verano de Rio Piedras, distant 12½ kilometres, has been completed. The circuit is a metallic one; bronze-silicium wires of 2mm. diameters are used, in conjunction with apparatus on the Brequet system.

The Writing Telegraph.—The Writing Telegraph Company have received the gold medal of the Franklin Institute. The company have recently worked out details by which the telephone can be successfully used on the same circuits, and are preparing to fit up a complete exchange with a large number of instruments at Pittsburgh.

Electric Soup Plates.—A Brazilian inventor has devised a method of keeping soup plates and other articles in their places on boardship in rough weather. This is, to have the plates fitted with an iron foot, and an electromagnet let into the table keeps the plate in position. He will require steel filing soup to keep the contents straight.

Sales by Auction.—Our readers should notice that a sale by auction, by Messrs. Wheatley Kirk, Price, and Goulty, will take place next Tuesday morning, at St. George's-circus, Borough, of a number of engines, dynamos, arc lamps, and electrical sundries, as well as a quantity of machine tools. These will be on view on Monday, and catalogues can be obtained from the auctioneers.

"Industries."—We are pleased to see that our respected contemporary *Industries* is taking unto itself a new home, and is removing its head offices to London. The Manchester and Glasgow offices will be kept on as before, and the London office will be removed from 22, Wellington-street, to 358, Strand, which will henceforth be their head office, to which communications should be addressed.

Segovia.—A private attempt is going to be made to light the city of Segovia, and to that end the engineer of the mining corps has been directed to make the necessary surveys, ordering from Messrs. Julius G. Neville and Co., of Liverpool, the machinery and fittings. Water power will be used, and the installation is to consist of 200 16-c.p. incandescent lamps, 10 lamps of 150 c.p., and two of 300 c.p.

Bourganeuf.—M. Marcel Deprez has communicated to the Paris Académie of Sciences a description of the electric lighting of the town of Bourganeuf (Creuse), which is done by power obtained from falls situated some 8½ miles away. The installation has been at work for three months, and has required no repairs during this period. Overhead wires are used, of silicium bronze $\frac{3}{16}$ in. diameter. It is quite bare, and is simply strung on porcelain insulators of the usual type.

Birmingham Post Office.—The *Gas World* seems to be rather surprised that the new post office at Birmingham is not to be lighted by electric light. Certainly, with an ardent believer like Mr. Preece in such authority in the department, we quite agree it would be well for all concerned to adopt the best illuminant. Post offices require light as the first requisite, and the abolition of heat and the closeness for constant workers is a great desidera-

tum. Perhaps we shall see it yet before the work is finished.

Electric Dental Instrument.—An electrical instrument has been invented by Mr. Fred Vernet, Hannibal, Missouri, says the *Scientific American*, which is designed to remove the pain incidental to the extraction of teeth. It consists of adjustable, pivotally connected prongs carrying buttons, and connected with an electrical battery, the buttons to be placed on the face over the nerves leading from the teeth to the brain, and a circuit established the moment the tooth-extracting instrument touches the tooth to be removed.

Sydney.—As will be seen in an advertisement appearing elsewhere this week, the Municipal Council of Sydney invite applications for the right to establish a central electric lighting station in that city. While so many companies are busy worrying the authorities of small towns and villages in England for the right to introduce electricity, it is gratifying to see that our colonial large cities are actively taking the matter up for themselves and applying to British enterprise. The system will probably bid fair to be one of the largest outside the European and American capitals.

"Colossus" Dynamos.—The American Brush Electric Company has received an order for, and has now nearly completed, another of the "Colossus" 500 h.p. dynamos for the Cowles Electric Smelting and Aluminium Company. This is the third "Colossus" dynamo built. The other two have been in regular service continuously since their completion. This same company also announces the sale in the last few weeks of 11 alternating current central station plants aggregating 8,600 lights. The merits of the new Brush system, recently described, are becoming much appreciated.

Kingston-on-Thames District.—A conference of delegates of various local bodies in the neighbourhood of Kingston-on-Thames was recently held in the Town Hall, Kingston, at which a resolution was passed suggesting that the authorities represented should combine for the purpose of making an application for a provisional order to supply their districts with electricity, on the understanding that no district is to be called upon to take a supply until it sees fit. The expense of obtaining the order is to be defrayed by the combined districts in proportion to their several rateable values on the 1st of January next.

Electric Mains Explode.—A new danger to the public streets has been unearthed (if one may use the word) by the occurrence of sundry explosions in the underground conduits of electric light mains, in which the leaky gas from the gas mains has obtruded itself, mixed with the air and constituted itself an amateur gas-engine. The danger has been so felt in some American towns, that special ventilating fans have been put down to keep a constant current of fresh air circulating. This is one solution; another will be found in the description of an underground system of mains with no spare air space, which is given in another part of the paper.

Worcester.—The notices of several companies of their intention to apply for a provisional order to supply electricity to the city were discussed by the Watch Committee of Worcester last Friday. The Town Clerk said it would be for the committee to consider whether the Corporation themselves should not apply for similar powers. Alderman Caldicott thought the gas company should take

the matter up, as they were the people who would be affected if electric lighting was adopted in the city. Mr. Corbett did not believe that the electric light was going to supersede gas. Eventually it was decided that the Corporation should not make any application.

Hastings.—On the recommendation of the committee, at the last meeting of the Hastings Town Council, it was resolved to apply for a provisional order for public lighting. It was understood private lighting was not to be included. A very discourteous letter from the gas company, in reply to one complaining about the candle-power of the gas lamps being below standard, was read, saying in effect, "We know nothing, go and ask your examiner"—Alderman Bradman alluding to it as one of the most disgraceful letters ever sent from one public body to another. The gas company are evidently not in very great favour, as it was suggested that an action should be instituted if the gas was found below standard again.

Rival Illuminants.—Great is the power of a little wholesome competition. In a recent paper before the North British Association of Gas Managers, the spread of electricity was deplored and greater activity, with different methods of business, were urged upon the gas companies by Mr. C. F. Edwards, of Napier, New Zealand, who gives some sensible advice on methods likely to increase the sale of gas. What will be the action of the ideal gas company of the future? he asks; and answers "It will adopt modern commercial methods; it will canvass for business; and it will" (actually!) "look after the interests of consumers." What are we coming to? The good old days of "take me or leave me" are past.

Electric Lighting at the British Museum.—As already announced in this journal, the electric light is being rapidly extended at the British Museum. The dynamos which were formerly employed have now been removed to make place for two large Siemens machines. A second Marshall engine will shortly be erected, together with two more dynamos. Two additional arc lamps of 3,000 c.p. have already been put up, one outside the main entrance, and the other just inside the lobby. The supplementary plant, which will shortly be installed, will supply current to a very large number of incandescent lamps which are to be fitted up in various parts of the building, especially in the labyrinth of corridors containing the shelves of books.

Liverpool.—We gave last week a report by the Dublin authorities on several cities adopting the electric light in England. In this it is mentioned that the system assigned to Liverpool is a high-tension one, reduced in the ordinary way by transformers. This, however, we understand is not the case, since the system employed is low tension throughout (110 to 115 volts E.M.F.). It is also stated in the report that the new electric mains and cables have not yet been brought into requisition, whereas for some months the mains have been in use in a large number of the principal streets, and new sections are rapidly being added. In addition to the Siemens dynamos mentioned in the Dublin report, there are also a number of Crompton dynamos at work in the Liverpool central stations.

Electric Lighting Extraordinary.—It has come to our ears that a most extraordinary enterprise is on foot in Derbyshire. According to our informant, a peculiar formation exists in one of the lead mines in that county. Not only is there a marked stratification of almost pure lead in the form of thick plates, but by a natural chemical action,

not easily explainable, the plates are coated evenly with peroxide of lead. Several enterprising capitalists have, it is said, taken advantage of this remarkable arrangement, and have succeeded in building a case of insulating and acid proof material around and under the whole formation. The next step will be to erect a large number of lightning-conductors in the vicinity of the mine to charge the enormous "accumulator"; and the supply to be obtained from one electrical storm of ordinary severity will, it is expected, be sufficient to light the entire county, yielding at least 10,000 ampere-hours!

The Motor to the Front.—An illustration of the handiness of the coming means of power transmission is forthcoming this week from Derby. On Monday last, the engine which drives the lathe and machine tools in Messrs. Davis and Sons' All Saints Works broke down badly, and in the usual course of things the shops would have been idle for the best part of the week. But Messrs. Davis have an auxiliary which, though uncommon enough here, is well-known and appreciated on the other side of the Atlantic, and in less than two hours and a-half a 5 h.p. electric motor, which had been leading a life of honourable ease on the ground floor, was hustled upstairs, bolted down, and belted to the shafting, and since then has been driving the machinery with the air of being quite accustomed to little incidents of the kind. The current for this motor is supplied from Messrs. Davis's central station electric lighting plant, and the motor may be seen in use during the week.

Barnsley.—Electric light is being actively proposed at Barnsley, and the gas company are not showing themselves wise in their generation by lowering their price as is getting habitual, but are actually raising it 4d. per 1000 feet. At the last meeting of the Barnsley Town Council mention was made of this, and the town clerk stated he had received notices from three companies who intend applying to the Board of Trade for power to supply the electric light in the borough. He read a letter from the solicitors of the National Electric Supply Company (one of the companies in question) setting forth their intentions, and asking if the Council themselves purposed applying for authority in respect of electric lighting. If they did not, and had no objections to the company putting down a permanent plant, they would be willing to provide for from 3,000 to 6,000 lamps as an experiment, and would be glad to supply the public with lights at per lamp or by meter. A motion was carried to refer the matter to the Lighting Committee.

Electric Automatic Sprinkler.—A new electrical fire alarm and automatic sprinkler, the invention of Mr. Shaffer, is being exhibited by Mr. A. K. Shepard, of 6, Craven-street, Strand. The transmitter consists of a small hollow iron box, filled with a material which expands under heat with great force. As it expands, it pushes upwards a brass piston, which, in rising, first makes contact with a strip of metal. This strip, being in connection with an electric bell, and the circuit being broken, an alarm is sent at once to any point in a building. The piston, rising further, next operates a compound lever, which opens the sprinkler, and admits the water through a sprinkler on to the fire, which thus becomes extinguished. The apparatus is so arranged that the alarm can be given in more places than one at the same time, and it can be made to indicate outside the building the exact locality of the fire within. This electric sprinkler is very sensitive to heat, and it is claimed for it that it is the only combined electrical fire

alarm and sprinkler. It is stated to be in extensive use in the United States.

Electric Tramway for Florence.—Italy seems to be moving in the matter of electric locomotion, and according to the latest news the Sprague Electric Railway and Motor Company have obtained a contract for electric tramway apparatus from the principal tramway company of Florence, Italy, for the equipment of their line. This apparatus includes an overhead system of the regular Sprague type, ten complete car equipments using two 15 h.p. motors on each car and station equipment complete. This will be the first installation of American street railway apparatus abroad. The present method of running street cars in Florence is partly by animal power and partly by small steel dummies, and it is thought that the electric cars will be in great demand. It is said that this order is only a small portion of a very large equipment which will be ordered by this company, and if the result proves successful, it is thought that very many other Italian cities will adopt electricity for their street cars.

Electric Pilot Car.—A new departure in railway management is proposed by Mr. Riesenbergh, manager of a sash and door works, St. Louis, to which the *Electrical World* gives unqualified approval, saying it should be universally adopted, though the system is evidently a tentative idea and open to practical objections. This is to have in front of express trains an electric pilot engine driven by an electric motor by a dynamo on the locomotive and connected to the main train by a cable which it keeps taut, as it "runs at a higher speed than the train itself" (tends to run, we suppose). This pilot car has a gong rung by each revolution of its front wheels and also two white upright discs that rotate to warn crossers off the track, and is furnished with an electric circuit to a bell on the main engine which would ring if anything happened to the pilot car. An arrangement allows the engineer to regulate the distance and play the pilot car like a lively fish when entering a station. It would thus act as automatic assurance that the track was free. The most remarkable part also is that the expense, after it is attached, would be "hardly any." Mr. Riesenbergh has the very laudable desire of wishing also to reduce the accidents to "hardly any."

Reporting Progress.—Last Monday, owing to the kindness of Mr. Kolle, we had an opportunity of having a look round the Deptford station, in company with genial Mr. David Brooks, of Philadelphia, who had an invitation from Lord Crawford to visit the mammoth works, and appeared duly impressed with the vast undertaking, as a retiring Yankee should under such circumstances. The roof and solid walls of the huge station can now be seen from the railway, and the largeness outside is typical of largeness inside. We are not able to give any details of the actual plant, description of which must be left to the press view of the first start up, which is to take place shortly. One of the so-called "smaller" huge engines and dynamos is ready, and the 10,000 h.p. dynamos will be added as the material comes in, which is a matter of some time, as the dynamo shaft weighing 70 tons we recently mentioned, after having taken its week to cool, will doubtless require a month or two to be turned up. Start will no doubt be made with the small dynamo, which is large enough to drive the whole of the Grosvenor installation. Coming back to town, we noticed running along the railway bridge to Charing Cross two huge lead-covered cables, which look suspiciously like the alternating-current main cables.

The Direct Production of Electricity.—The following account is given in the *Electrical World* of a system for the direct production of ammonia from coal and also electricity from the same mineral, though it does not appear whether the invention claimed is of American or Continental origin. Mr. Mond has invented, in conjunction with Dr. Lunge, a dry gas battery for producing electricity direct from the gases made in producers, and a new process for converting the carbonic oxide and carbo-hydrates contained in these gases into their equivalent of hydrogen, by passing them together with steam over metallic nickel or cobalt at a moderate temperature, so as to make them suitable for use in the gas battery. This battery consists of diaphragms of gypsum inserted in a barrow-like frame composed of antimony and lead, impregnated with sulphuric acid, and covered on both sides with very thin perforated platinum leaf and a thin film of platinum block, which are connected to the poles of the battery by suitable conductors, and are exposed on one side to gases containing oxygen, and on the other to atmospheric air. In this way an electric current is set up. The hydrogen is oxidised to water, and fully 50 per cent. of the energy it can yield is, it is claimed, converted into electricity. In shape the battery is oblong, the measurements being about 12 in. long, 1 in. broad, and 3 in. deep. Into this the diaphragms, which have something of the appearance of a chessboard, are placed.

Leeds Town Hall.—The Electric Lighting Committee of the Leeds Corporation met on Wednesday to experiment with the Brockie-Pell arc lamp as an illuminant for the exterior of the Town Hall. Only one lamp was tried, but the results of the experiment amply satisfied the committee and all present of the success of the experiment. The lamp, which was of 2,000 c.p., shed a soft and remarkably steady light, strong enough to enable a person possessing ordinary visual power to read a newspaper 30 or 40 yards distant. The committee was so thoroughly satisfied with the outcome of the trial that it intends, within about a fortnight, to have eight of these lamps fixed around the Town Hall—three of them being in Calverley-street, three in Oxford-place, and one in front and another at the back of the Town Hall. It is proposed to utilise the existing gas-standards around the Town Hall for this installation, that forms part of a scheme for which the Town Council granted the Electric Lighting Committee £3,000 recently. This arrangement for replacing gas by electricity is, we understand, not only to promote the convenience of the public during the approaching Musical Festival, but will be permanent. It would be impossible, without adding to the existing plant, to spare power sufficient, after lighting the interior of the Victoria Hall and the Municipal Buildings, to supply more than eight of these arc lamps around the Town Hall, but this number will be quite enough to thoroughly answer the purpose, if they all work as well as the one tried. The installation is being carried out under the superintendence of the borough engineer, Mr. Hewson.

Collapse of the "Peral."—The electric submarine torpedo boat "Peral" has apparently come to an untimely end. According to reports, the first trial took place last March, and though the inventor had been fêted to the farthest extent, in advance, the trial did not prove very successful. Lieutenant Peral said the machinery was too weak, and sent it back to England to be remodelled. In June the machinery was returned, and early in August all the big Spaniards of Cadiz and Madrid were invited to attend Peral's triumph. Peral, several officers, and a

crew put out into the harbour in the famous craft, which is described as resembling in appearance an enormous cigar. Everything about her was close and smooth. The boat floated about 300 ft., and the crowds at the docks shouted deliriously. Just as everyone was expecting her to dive under water, however, her whole electrical apparatus began to run in a most unaccountable fashion. Two or three things exploded with tremendous force. The big cigar trembled a minute, and the frightened crowd was still. Then came a volley of loud reports like the rattle of musketry, the hatches of the boat were thrown open, and Peral, officers, and crew tumbled out into the water. From the open hatches issued flames, smoke, and flying bits of machinery. Two minutes later the big cigar rolled over and disappeared. The men who had risked their lives in her hold were picked up by rowboats. Three days after the catastrophe Senor Casado arrived in Cadiz from South America to see what kind of a craft his 500,000 francs had enabled Peral to build. He couldn't find even the wreck.

Series Lighting at the Birmingham Exhibition.

In addition to the general arc and incandescent lighting in series throughout the machinery hall already reported upon, Mr. Goldston has now added, in accordance with a special request of the executive committee, two more arc lights (Brush), 2,000 c.p., under the main portico outside the entrance of the exhibition, also in series with them a number of 65 c.p. and 32 c.p. series incandescent lamps (of the Bernstein type). The extremely steady burning of the arc lamps, and the intense whiteness and regularity of the incandescent lights, are very conspicuous, and the members of the committee express themselves highly satisfied with the arrangements as carried out to meet the requirements. We may add that Mr. Goldston's arc and incandescent circuit now extends from one side of the building to the other, and that although the whole of the lamps, both arc and incandescent, are in direct series with one another, yet by the arrangement in connection with his automatic cut-out devices, placed at certain sections, even should the circuit become broken in any way this would not necessarily put out the whole of the lamps on the circuit, but the faulty portion only would be automatically cut off, and the remaining circuit lamps would keep alight. Mr. Goldston has also a small motor on his exhibit in series with his general circuit driving a small lathe, made by the Britannia Company, Colchester. Visitors to the exhibition interested in the question of long-distance distribution can, therefore, see clearly demonstrated a capital example of combined arc and incandescent lighting, and transmission of power, on the series method, on Mr. Goldston's system.

Domestic Electric Lighting.—A very successful and novel experiment has been made by Messrs. Field and Son, jewellers, in the Market-square, Aylesbury, with the object of testing the adaptability of the electric light for domestic and business purposes. The installation is one of great interest, and is probably one of the first instances where the electric light has been used in such a manner by private enterprise for the combined purpose of lighting the business and private residences where they are situate some distance from one another. The motive power is supplied by a Crossley vertical gas engine, driving a dynamo of 60 volts, 12 amperes, in conjunction with 26 accumulators. Edison-Swan lamps to the number of 40 are used, varying from 8 to 25 c.p. The office, shop, shop-window, and entrance are lighted by eight 8, six 16, and one 25 candle lamps; the workshops and basement by

lamps varying from 8 to 25 c.p. Each lamp is controlled by a switch, conveniently placed. By a simple and perfectly safe arrangement, Mr. Field sends the light over to his home on Rickford's Hill, and illuminates each room with it. This is effected by means of overhead wires between the two houses, which are also used for the twofold purpose of telephonic communication in the daytime, and locking them together at night with the burglar contacts and fire alarms that are attached to the iron safes and glass cases containing the valuable stock at the shop. The engine and dynamo, with the storage batteries, are fixed in the basement under the shop. No inconvenience is experienced from their proximity in working, nor can the slightest vibration be perceived in the lamps, even when working directly off the dynamo.

Records by the Electric Launch "Eta."—On Saturday, the 7th inst., a small party, consisting of Mr. A. Rawlinson, of Brighton, Mr. Saunders, of the Miller of Mansfield Hotel, Goring, and Mr. Volk, manager for Messrs. Immisch and Co. at their Electric Launch Works, Platts Eyot, Hampton, started from Hampton for Oxford in the electric launch "Eta." Maidenhead, the first stopping place, a distance of 26 miles was accomplished in four hours without making any allowances for time occupied in passing through the locks—the "Eta" being recharged during the evening at Messrs. Immisch and Co.'s electric charging station at Maidenhead. On Sunday an excursion was made to Medmenham and back. The interest in the trip, however, increased on Monday with the run to Goring, 34 miles, when the "Eta" had again a recharge during the night. Resuming the journey from Goring at 10 o'clock on Tuesday morning, the distance to Oxford, including two stoppages, was covered by 4 o'clock in the afternoon. During the two hours the "Eta" remained at Oxford she attracted considerable attention, being the first electric launch that had navigated above Goring, and a number of the boating public whose curiosity had been excited by the accounts and illustrations of these launches, had an opportunity of examining the handsome and attractive "Eta." Leaving Oxford at 6 p.m., a stop was made at Abingdon for the night, Goring being reached by noon on Wednesday. During lunch the launch had a small charge, after which continuing the journey to Reading, leaving there on Thursday morning at 8 o'clock. A short stay was made at Henley, arriving at Maidenhead, the end of the journey, by 1 p.m. It is noteworthy that no loss of time occurred in the charging of the launch, which was effected during the night or meal times, and also that a distance of 60 miles, from Goring to Oxford and back, was accomplished with but one charge of electricity. The "Eta" has therefore constituted two records, one for distance and the other for work done. Her owners have just cause to be satisfied with her performance.

Death by Electricity at Brighton.—The following letter from Dr. R. Whittington Lowe, of Brighton, appeared in the *Times* of yesterday: "I notice in the *Times* of to-day (17th) some remarks by Mr. W. H. Preece, chief electrician to the General Post Office, spoken at the meeting of the British Association on Monday, in which he refers to the late death by electricity at Brighton. As the medical man engaged in that case, I hope you will be able to spare room for a few hurried notes. From your report it appears that Mr. Preece made the statement that the electrical current had stopped running two hours before the death of the unfortunate man, thereby

inferring that this could not be a death by electricity. This is altogether incorrect. The man was found dead at 6 a.m., lying about 3ft. below a wire which carries a current of 2,000-volt power, the said wire being pulled downwards from its position about 2ft. The hand and face of the man, being uncovered, were cold, and he had probably been dead from an hour to an hour and a half, or thereabouts, which would fix the time of death between 4.30 and 5 a.m. I gather from the *Times'* report of Mr. Preece's remarks that Major Cardew was sent down by the Board of Trade to investigate the case, and so complete does the investigation appear to have been that I have heard nothing of it, nor have I been asked a single question as to the man's death. Mr. Preece's remarks seem to be based upon a statement made by some of the employes of the electric light company, to the following effect—viz., that at about 4.30 or 4.40 a.m., on July 15, there was a flash of lightning, followed by thunder, which caused so great a disturbance to the electric light company's works that the current was immediately interrupted, and was not again set running, owing to the damage which had been done. Now, it follows that if the exact time of this accident to the machinery was, as here stated, not later than 4.40 a.m., and the man was alive later than 4.40 a.m., he could not have been killed by the electric current passing through the displaced wire. Here comes a little difficulty. The dead man was night man at the brewery where he met his death, and had charge of the engine, the fires of which it is believed would not burn for longer than one hour without attention. The fire, although very low, was burning when the daywork men arrived at 6 a.m., so that, at first sight, it would seem that the deceased must have attended to the fire as late as 5 a.m., or 20 minutes later than the electric company's men say the current stopped running. To clear up this difficulty, two things are necessary—first, that the time of the accident to the machinery should be proved exactly; and, secondly, it must be shown that the engine would not run for more than an hour without attention. Through the courtesy of Messrs. Hallett and Abbey, to whom the brewery belongs, I hope to have the latter point experimentally determined, and I think Mr. Preece had better undertake the proof of the exact time of the flash. There are several other points which Mr. Preece may possibly be able to clear away—first, what caused the wire to be pulled down 2ft. at the point where the dead man lay; second, what, in the absence of any sign of disease after a post-mortem examination, was the cause of this strong young man's death; third, what caused the line of abraded skin on the side of the neck, which I, as well as all the jurors at the inquest, regarded as the consequence of contact with the wire; fourth, why the electric company offered the deceased man's widow £180 as compensation; fifth, why, when this sum had been declined, and an action is pending between the widow and the electric light company for heavier damages, the time of the lightning flash becomes more definite; sixth, why the electric company's solicitor at the inquest did not occupy such an unassailable position on behalf of his clients as Mr. Preece has discovered; seventh, and lastly, let me ask if Mr. Preece, since he considers that the wires may be handled with perfect safety, is prepared to give us a practical demonstration on this point by laying hold of this 2,000-volt electric wire, which without doubt killed the poor man on the early morning of July 15, 1889."

THE DESIGN OF TRANSFORMERS.*

BY JAS. SWINBURNE.

So much has been already said on the design of transformers, and so many calculations have been made, and so many formulae given, that it would seem at first sight as if there was little that could be added.

The greatest change that has taken place recently in the practice of transformer design has been the substitution of a continuous iron core interlinked with the copper coils, for a straight core with wires wound on it, as in the Ruhmkorff coil, and the secondary generators of MM. Gaulard and Gibbs. The idea in making this change is that the continuous iron core needs fewer current-turns to produce a given induction, and this is generally considered to be of the first importance. With the object of getting the necessary excitation as small as possible, makers give the iron core as large a cross-section and as short a length as possible; and the tendency of designers is to increase the iron and diminish the copper of their transformers. The question of loss of power in heating of the cores does not appear to receive enough attention, and the object of this paper is to point out that many common designs produce very inefficient transformers, and that in many cases a particular form of "open circuit" transformer is the best.

If a transformer, with a full load output of 1,000 watts, has a loss of 50 watts in the copper and 150 in the iron, its full load efficiency is 83.5 per cent. But suppose it is put in a house wired for, say, 17 lamps, the full load is on only very occasionally, about half the lamps being the usual maximum. The proportion of the lamps lighted to those wired varies. Some authorities take it that the average is equal to all the lamps on one hour a day, others say three, or even five hours a day. If the full load is on two hours a day, and the transformer stands idle, merely keeping its iron hot all the rest of the time, its average efficiency is only 35 per cent. Many will at once say that the loss of 150 watts in a 1,000-watt transformer is absurd, and that modern transformers work at something like 98 per cent. full load efficiency. The figures generally given by makers are so obviously impossible, that one is driven to conclude that the loss in iron is not measured.

As a matter of fact, the measurement of this loss is no easy matter. Before bringing forward a paper like this, it might be said that I ought to produce a number of accurate data, giving the loss at various inductions, at various frequencies. Unfortunately, I cannot do so. We must, therefore, rest content with Prof. Ewing's determination of the curve of a single specimen of iron magnetised very slowly. No doubt it is perfectly accurate, but we want a great many curves taken with different samples of commercial iron, and perhaps different frequencies.

It is commonly assumed that a low induction should be used in transformers, because the heat lost per c.c. of iron per cycle is then less; but it is forgotten that more iron is then needed. The volume of iron needed does not vary inversely as the induction, it increases quicker, as the iron is bent round the wire coils. The copper coils have also to surround more iron if its section is increased, and this entails more loss over resistance. On the other hand, the loss per c.c. of iron increases more quickly than the induction, but not much more quickly, so that it may often be advisable to use a high induction.

Before going farther, it will be well to explain some of the terms used in this paper. The square root of the mean square of the E.M.F. is called the virtual E.M.F.; so that an electrometer or non-inductive voltmeter measures the virtual E.M.F. The square root of the mean square of the current, or the current as measured by a dynamometer, is called the virtual current. Thus the product of the virtual E.M.F. and virtual current on a non-inductive resistance give the real power, and so on. Roughly speaking, the virtual current and E.M.F. may be taken as 10 per cent. greater than the mean E.M.F. Similarly, the virtual induction is measured by the virtual E.M.F. it produces. The mean induction need never be considered, as the question of heating depends on the maximum induction. The virtual induction is thus a maximum of about 10 per cent. less than would be necessary to give the corresponding mean E.M.F. The maximum induction again depends on the maximum excitation, and not on the mean excitation. To get a maximum induction of 1 needs a maximum current of 1; it needs a mean current of about $\frac{2}{\pi}$ or .64, or a

virtual current of about $\frac{1}{\sqrt{2}}$ or about .7. But a maximum induction

of 1 is equal to a virtual induction of about 1.1, so that a virtual induction of 1 needs a virtual exciting current of about .64. As an example, suppose a long core of one centimetre cross-section wound with wire, and suppose with a direct current one ampere per centimetre produced an induction of 10,000. If the direction of magnetisation alternated perfectly uniformly at a frequency of 2,500 per second, it would induce one volt per turn of wire round it. But if the magnetisation does not increase and decrease perfectly uniformly, the mean E.M.F. will remain one volt per turn, but the virtual E.M.F. will be greater. Take now the case of an alternating current, and find what virtual exciting current will be needed to induce one virtual volt per turn at a frequency of 2,500. The virtual induction needed will be 9,000. This will need a maximum exciting current of .9, or a mean current of .9 x .64, or a virtual current of .9 x .7, or of .64. If the direct exciting current of 1 lost one watt in a given length of wire, the corresponding alternating current will lose only about .4, or less than half.

In making calculations to find the proportions which give highest efficiency it is clear that the interlinked coils must be as in the figure, in which the single link may be either the copper or the iron. If the

* Paper read before Section G of the British Association at Newcastle.

cross-sectional area of the single link is equal to that of the pair, the pair will have less volume. If the waste of power per cubic centimetre of iron is greater than that of the copper, the wire will take the form of the pair of links, and the single link will be the copper wire. To get the best result the cross-section of the coil and core will be very nearly, but not quite, square. In the following calculations they have been assumed to be square, which can make no perceptible difference in the efficiency, and makes the calculations easier by removing two variables. The problem now proposed is: Given the desired output of the transformer, to design it to give the highest efficiency. Call the side of the section of the iron core x , and the side of the section of the copper core z . All the other dimensions of the transformer depend on x and z . We now have to find the loss in the transformer in terms of known quantities and of x and z , and have then to choose x and z so as to make this loss as small as possible.



FIG. 1.

The waste in the iron core is equal to the waste per cubic centimetre of iron multiplied by the volume of the iron. Call the loss per cubic centimetre at the induction and frequency under consideration, l . Then

$$\text{Power spent in core} = l x^2 (4z + 2x) = 4l x^2 z + 2l x^3.$$

The loss in a cubic centimetre of copper varies as the square of the current density. The most economical current density ought, properly speaking, to be determined by taking the current density as a variable; but it is generally so high that the coils would get hot. At first sight it may seem strange that a piece of apparatus that gets hot can be more efficient than one that keeps cool; but it must be remembered that the temperature depends on the facility for dissipating the heat, and a large transformer can lose more heat by radiation and convection than a small one, and can thus keep cool, though less efficient. Similarly a dynamo that gets hot is not necessarily inefficient. Heating is inadmissible on the score of durability and safety, so a current density must be assumed that will not cause excessive rise of temperature. The current density can generally be settled beforehand, as the size of the coils will be roughly known, and a safe density can be taken. If the loss per cubic centimetre of copper, with a current density of one ampere per square centimetre, is called p , the loss per cubic centimetre of copper is $p d^2$, d being the density in amperes per square cm. As the output is known, and the current density is assumed, and the thickness of insulation is also known, the proportion of copper to the whole volume of the coil is known. Call this k .

The loss in the copper is then $k z^2 p d^2 (4x + 4z)$, so the total loss in the transformer is

$$4l x^2 z + 2l x^3 + 4k p d^2 x z^2 + 4k p d^2 z^3.$$

In this expression the extra loss of power due to the magnetising current in the primary coil is neglected, as it is exceedingly small. The magnetising current is itself small, and differs in phase, roughly, a quarter of a period. Thus, if the magnetising current were even 10 per cent. of the full load current, the full load loss in copper would only be about 1 per cent. more than here allowed. If B_0 is the virtual induction in the core, and n the vibrations per second, $4 B_0 n \times 10^{-8} x^2$ is the E.M.F. per turn of primary or of secondary wire. The total E.M.F. is $4 B_0 n x^2 \times 10^{-8}$ multiplied by the number of turns in the primary or secondary coil. The output of both coils, or twice the output of the transformer, or $2P = 4 B_0 n x^2 \times 10^{-8}$ multiplied by the ampere-turns in both coils. The ampere-turns = $k d z^2$, so that

$$2P = B_0 n \times 10^{-8} \times k d x^2 z^2;$$

$$\text{therefore, } z = \frac{1}{x} \sqrt{\frac{2P}{4 B_0 n 10^{-8} k d}}.$$

Call the coefficient b , then $z = \frac{b}{x}$.

The total loss is thus

$$4l b x + 2l x^3 + \frac{4k p d^2 b^2}{x} + \frac{4k p d^2 b^3}{x^3}.$$

$$\text{So that } 4l b + 6l x^2 - \frac{4k p d^2 b^2}{x^2} - \frac{12k p d^2 b^3}{x^4} = 0,$$

or

$$3l x^4 + 2l b x^2 - 2k p d^2 b^2 x^2 = 6k p d^2 b^3.$$

This can be solved as a cubic equation for each transformer wanted, or by trial. In practical work, an exact solution of such an equation is not required, as any dimensions that even approximately fit the equation give sensibly the same efficiency. Thus x can be made a round number of millimetres, or of eighths of an inch. If a complete table of transformers is wanted it may be shorter to make a finite difference table increasing x^2 , the cross-sectional area of the core by jumps of, say, two square centimetres. Or the table may be calculated directly with the aid of a slide rule. In practical work a great deal of time may be wasted, not on legitimate calculations, but on work containing clerical errors, and on trying to find out the mistakes and to see how they got there. Anyone who is an inaccurate worker may, therefore, prefer to make a table in such a way that if the last term is right all the rest must be right too.

A complete set of closed circuit transformers was designed by me for Messrs. Crompton and Co., the waste in copper and in iron, and the cost of material and the efficiencies under various circumstances being worked out. In this case the loss in iron was assumed to

be about half as much again as in this paper, as that seemed a fair margin for practical work, though it might not be assumed for argumentative purposes. Most of them were calculated for a frequency of only 33 per second; as I found that led to great saving in the manufacture of the dynamo, and led to small extra cost and loss of efficiency in the transformers, some of these tables may be shortly discussed before going farther. The induction is taken at 14,000, and the loss is taken at 14,600 ergs per c.c. per cycle, or .024 joules per cubic inch.

The tables were calculated with the object of being useful, so the dimensions are in inches; as in practice one always uses inches. When one's sole object is the advancement of science, of course he rises to centimetres.

In table I, the first column gives the number of 60-watt lamps. The second and third give the diameter or size of wire in inches in the primary and secondary coils. The dagger means that the wire is square. The fourth and fifth give k and b , which are mere coefficients as before. The column x gives the side of the core, and z the side of the coil in inches. The next columns give the loss of power in watts. The cost of material in the last columns is in shillings, taking iron at 3d. and copper at 9d. a pound. Table I. is calculated for transformers on full load the whole 24 hours.

It must be borne in mind that these tables do not give sizes for actual transformers, but act as guides to give the dimensions that should be approached. For instance, the sizes of wires given are no particular wire gauge, and no room is left for cheeks or formers for the coils. The secondary wires would not fall into whole numbers of layers.

Table II. is calculated for 16 hours a day. That is to say, the transformer is supposed to have the secondary open a third of the time. The transformers have then to be redesigned, as the loss in iron becomes relatively more important. It will be noticed that the efficiency begins to fall off and the price to go up. If transformers from table I. were used only 16 hours a day, the efficiencies would be lower than those in table II. Tables III. to VI. need no further explanation. It is well to point out that a great deal depends on the way the time is estimated. Full load one hour a day is not the same as half load two hours a day. Half load two hours a day would have less copper waste, so to make the best transformer the copper would be increased and the iron lessened. These last transformers are really absurdities; the 50 lights in table VI. has an average efficiency of only 60 per cent. and costs about £20 for material only. The E.M.F. has so far been assumed to depend only on the induction in the iron core, but when the core is so small and the coils are so large, this is no longer even approximately true, as will be explained later.

Table VII. is to show what may be gained by transforming from 1,000 to 50 volts, instead of from 2,000 to 100. The difference is due to the difference of room taken up by the insulation. The table is made for 50-light transformers, designed for the various times of full load. The column of efficiencies at 2,000 and 100 volts is for transformers designed for these volts, not for the same transformers merely rewound. The difference would be greater if the same transformer were used in each case. It will be seen that the efficiencies and costs are very little reduced by using low tensions; but as the percentage fall of E.M.F. on the lamps is increased by using the most efficient transformer, it would be best not to design the low-tension transformer with a view to efficiency only.

Table VIII. shows the effect of using transformers for time loads for which they are not intended. It is constructed for various 50-light transformers. The power spent in the copper remains the same in each horizontal line. The waste in the iron during the whole day is concentrated into the hours of lighting, as before. Thus a full time 50-light transformer has an efficiency of 92 per cent. on full time, but only 44.2 per cent. with full load an hour a day. The 50-lighter, specially designed for one hour a day, has an efficiency of 60 per cent., but at 24 hours a day it only rises to 82.3 per cent. The fall of E.M.F. on the lamps is also quite out of the question.

TABLE IX.—Fall of Sec. E.M.F. 2,000 p.p.m.

Lamps.	Hours.	16	8	4	2	1	24 1
...	24	12.85	14.85	...	...	...	with 5,000 p. per min.
2	6.75	11.8	9.5	...	...	...	
5	6.5	8.3	7.7	11.3	15.8	26.6	
10	4.65	5.6	7.2	10.65	17.75	25.6	
25	4.65	4.95	8.3	10	14.5	23.7	2.76 14
35	3.9	4.35	5.65	8.3	13	19.5	
50	3.42	4.25	6.7	8	11.8	17.8	
50*	3.46	4.35	5.5	7.5	10.5	17.8	
70	3.25	4.2	4.07	8	10.2	15.3	1.15
100	2.83						
160	2.5						
250	2.1						
400	1.8						
650	1.6						
1,000	1.5						

* This line at 1,000 to 50 volts.

Table IX shows the percentage fall of secondary E.M.F. at full load. The table, like those before it, is for a frequency of 33. The last two columns show the advantage of using 80 per second. The loss in a 50-lighter is 2.76 instead of 3.42 per cent. in the case of 24 hours, and 14 per cent. instead of 19.5 for the one-hour transformer. The 1,000-lighter would be for sub-stations, and would never have its primary on and its secondary off, so it is taken for 24 hours only. The fall is 1.5 per cent. at 33, and 1.15 at 80.

It is needless to remark that when the variation of terminal E.M.F. is great, it is very much more important than the efficiency of the transformer itself, as it affects the efficiency of the lamps, and thus of the whole system.

Table X. is for three transformers for a frequency of 80. The 1,000-lighter has an efficiency of 97.2 instead of 96.75, or an increase of .45 per cent. Its cost of material is £13. 10s., instead of £20. 10s.

The efficiency of the full time 50-lighter is 93 against 92, and its cost of material is £1. 13s. 6d., against £2. 8s. 6d. This must, of course, not be confused with the cost of the transformer, which includes many other items.

Leaving these tables, as the induction might be considered too high, and as the loss might also be considered excessive, we may return to our equation:

$$3 l x^6 + 2 l b x^4 - 2 k p d^2 b^2 x^2 = 6 k p d^2 b^2,$$

The more usual frequency of 80 per second will be taken. The current density, d , will be taken at 150 amperes per square cm., which is about 1,000 per square inch. The primary will be taken at 2,000 volts and 1.5 amperes, and the secondary at 100 and 30. Allowing for double cotton insulation, and assuming the sectional area occupied by a wire to be the square of its over-all diameter, $k = .375$.

To find l , the waste of power per c.c. of iron for any virtual induction, such as 10,000, we may take the loss per c.c. from Prof. Ewing, and multiply by the frequency; this allows a margin for the air spaces among the wires or plates, and comes about right with round wire. It is not likely that the iron used in commercial transformers is nearly so well annealed as Prof. Ewing's specimen, and it is generally handled a good deal in the workshops. A small allowance should also be made for Foucault currents. Some authorities would also make an addition for viscous hysteresis.

The specific resistance of copper is about 1.8 microhms. All the coefficients in the equation can now be replaced by numbers.

In the tables already given the induction was always 14,000; we will now work out some examples with low and high inductions for various time loads, but always, for ease of comparison, for 50 lamps, or 3,000 watts.

No. 1, with virtual induction of 7,000, designed for full load always on, has an efficiency of 95.2, and a drop of E.M.F. of 2.3.

FIG. 2.

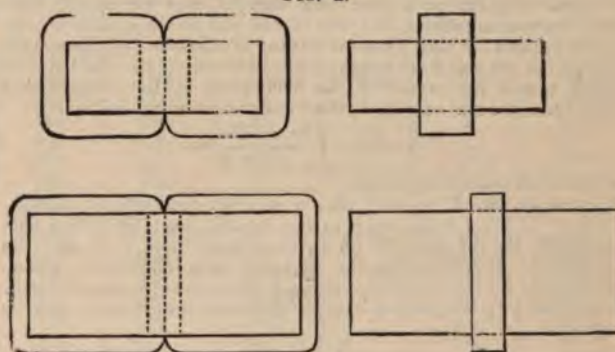


FIG. 3.

The same transformer run at full load for two hours a day, or at half load for 8 hours a day, has an efficiency of 74.7. The figure is to scale.

No. 2, with same induction, designed for two hours a day, has 81.5 efficiency, and at full load always its efficiency goes up to 92. Its drop is no less than 7.3.

No. 3, with virtual induction of 10,600, designed for continuous load, has 95.1 efficiency, and at two hours a day, 72.5; drop 2.2.

FIG. 4.

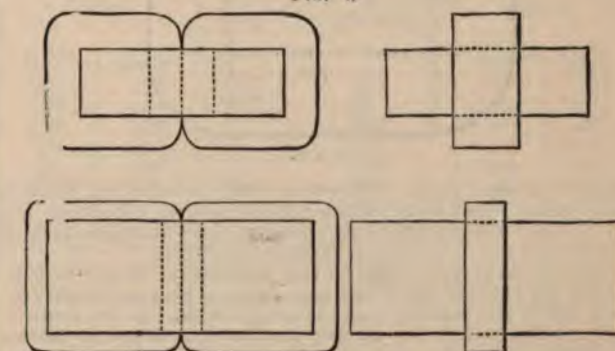


FIG. 5.

No. 4, same induction, designed for two hours a day, has 81 efficiency, and 91.5 under continuous load, the drop being 8. No. 5, with induction of 14,000, has efficiencies of 94.6 and 71.2, and drop of 2.3.

No. 5, with induction of 14,000, has efficiencies of 94.6 and 71.2 and drop of 2.3.

No. 6, with same induction, designed for two hours a day, has 77.5, and 90 per cent. on continuous full load, drop being 9.2.

These examples show that a low induction is a little better, but it can hardly pay for the extra cost. The chief point is that the best full load transformer is bad for short loads, but a short load transformer, though more efficient at short loads, and not much inferior under continuous full load, is a hopelessly bad regulator, besides being too expensive in copper.

Suppose, instead of a closed iron circuit, we use a transformer of

the Ruhmkorff coil type. The iron will be less, but the magnetising current will be considerable, especially in small sizes. To reduce this difficulty, I carry the ends of the wire cores out past the cheeks of the coils, and then spread the wires out into a sort of thistle head or hedgehog. The magnetising current cannot even then be left out of account, as it may be very considerable. The magnetising ampere-turns depend on the dimensions of the transformer, and the size and current density of the primary depend partly on the magnetising current, and these quantities are involved in such a way that a calculation to find the best form for a given case gives three complex and unmanageable simultaneous equations. It is much quicker to find the best form by trial, altering one dimension at a time, as independent variable till a good result is obtained.

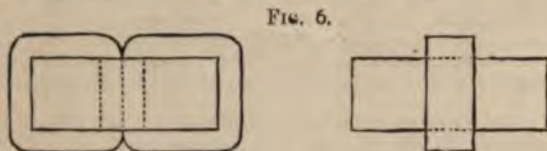


FIG. 6.

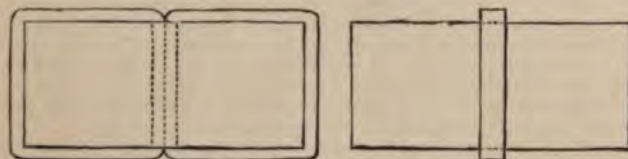


FIG. 7.

To get the magnetising current, or the primary current at no load, the bushy end is taken as having a hemispherical surface, and the direction of the induction in the air is taken as radial, whereas it really curves round on all sides to the other hemispherical surface. The magnetising current is thus very slightly over estimated. The primary current is taken as the root of the sum of the squares of the magnetising and the main current. Calling the diameter of the core w , the length of the coil and straight part of the core l , the thickness of winding z , and the radius of the hemisphere y , the magnetising ampere-turns per cm. of iron, h , the total excitation needed is

$$h(l+2y) + \frac{B_0 w^2 \cdot 64 \pi y}{16 \pi y^2}$$

The first term may be neglected.

As example, No. 7, we may take a medium induction of 10,600, and take w as 5.5, l as 25, and y as 8. At full load, for which this is designed, the efficiency is 96.2; at 2 hours it is 77.3, and the drop is 2.46. In estimating the efficiency at 2 hours a day, allowance is made for the loss in the primary when the secondary is open. This is small in power, but it is of considerable importance as it is always on.

FIG. 8.

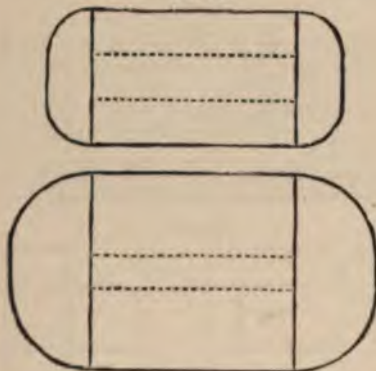


FIG. 9.

No. 8 is for short loads. The core is 4 cm. diameter, and the ends 10 cm radius. Its 2 hours' efficiency is 86.6, and at continuous full load it is 95. The primary current density is here taken less to keep down the loss due to the no load magnetising current.

Table XI. shows these results for easy comparison. It will be seen that the last example has at full load almost as high an efficiency as 1 or 3, which were specially designed for full loads. At two hours it is very much superior; but its drop is rather serious, and it takes a lot of copper. No. 7, on the other hand, though designed for constant full load, has nearly as high a light load efficiency as the closed circuit light load transformers, and has a small drop, and has least material of any.

The diagrams show that the closed circuit transformers designed for light loads are absurdities that no one would think of making. It must also be remembered in connection with them that the assumption that the only E.M.F. induced in the coils is due to the core induction is obviously absurd.

Where the copper coils are relatively small, it may be assumed that the E.M.F. in each depends only on the iron; but in all the cases given allowance must in practice be made for lines of induction which do not pass through the iron, produced by each coil. Obviously, it would be best to mix the primary and secondary wires together; but there are great practical objections to this, as the wires are then difficult to insulate properly, and the capacity of the transformer as a condenser may be great enough to involve danger to life.

TABLE XI.

No.	B_0	Power.		Efficiency.		Drop.
		Iron.	Copper.	24 hours.	2 hours.	
1	7,000	80	65.5	95.2	...	2.3
"	"	960	"	...	74.7	"
2	"	453	220	...	81.5	7.3
"	"	38	"	92	...	"
3	10,600	88	66.5	95.1	...	2.2
"	"	105.6	"	...	72.5	"
4	"	477	240	...	81	8
"	"	40	"	91.5	...	"
5	14,000	101	69	94.6	...	2.3
"	"	1212	"	...	71.2	"
6	"	590	275	...	77.5	9.2
"	"	49	"	90	...	"
7	10,600	44.5	74	96.2	...	2.46
"	"	534	349	...	77.3	"
8	"	276	197.5	...	86.5	4.35
"	"	23	130.5	95	...	"

Probably transformers for very short loads could be made very much better than Nos. 2, 4, or 6, without any iron. In 1882-3, seeing in an electrical textbook that an iron core merely concentrated the lines of induction without increasing their number, and knowing no better myself, I argued that as there was loss of power in magnetising the iron, a transformer with the wires mixed would do without iron. I made one with a commutator driven by a motor for direct currents. It lighted part of a Swan carbon, but gave a very small output, and the commutator sparked. I also tried an alternating current; but, as a matter of fact, the transformer was very badly designed. Messrs. Gaulard and Gibbs were really first with mixed wires, which is not a point of no importance, even with cored transformers. I took out a patent in 1884, when the fees were reduced, but it is not even worth the reduced cost. It is merely a matter of theoretical interest that with mixed wires and a lavish expenditure on copper, an efficient short load transformer might be made. In the transformers we have discussed the coils must be separated, and the primary has to be given fewer turns, and the secondary more, to give the right output.

The loss by Foucault currents has not been taken into account in this paper, as it can be reduced to any desired extent by laminating or using fine wire; but the plates must be very thin to make it really negligible.

Take a piece of wire 1 cm. long, of radius r . The virtual E.M.F. on any elementary layer is $4 B_0 r^2 \pi n$, and the resistance of such a layer is $\frac{2 \pi r R}{d r}$, where R is the specific resistance of warm iron

say 10 microms. This gives the power $\frac{2 B_0^2 10^{-16} n^2 \pi r^4}{R}$ in the

little piece of wire. There are $\frac{1}{4 r^2}$ pieces per c.c., so the watts

per c.c. = $\frac{B_0^2 10^{-16} n^2 \pi r^2}{2 R}$. To reduce the Foucault current

heating to one-fifth of the hysteresis heating at an induction of 10,000 with 80 periods per second needs wire .06 cm. in diameter, which is between Nos. 24 and 25 B.W.G.

The Foucault heating in punchings of sheet iron cannot generally be calculated, but is near enough for our purpose if we take circular punchings like dynamo discs of about the same size. For instance, instead of punchings to suit No. 1, we can take washers of 10 and 20 cm., internal and external diameters. The power lost in a disc by Foucault currents is

$$P = \int \frac{8 B_0^2 10^{-16} n^2 \pi r^2 dt dr}{R} \text{ or } \frac{8}{3R} B_0^2 10^{-16} n^2 \pi^2 \text{ per c.c.}$$

To give a Foucault current loss equal to one-fifth of the hysteresis loss, with an induction of 10,000 and a frequency of 80, needs sheet iron .031 cm., or just over No. 30 B.W.G. Of course there are similar losses in iron-cored dynamos. For the thicknesses of iron in common use, the tables I. to X. are probably not far wrong.

In conclusion, it would seem that from the point of view of the coal bill at the central station, that the system of putting transformers permanently on in houses is hopelessly bad. But the coal bill is not everything. The cost of electrical energy does not vary as the coal burned. The house transformer system has also the disadvantage of variations of secondary E.M.F.

Assuming the private transformer system to be necessary, the open circuit transformer, of the kind I have now the honour of explaining, is better for such sizes as 50 lights. If larger sizes are needed the hedgehog kind easily distances the closed circuit; for its drawback is its large magnetising current, and the excitation is less in proportion as the transformer is increased. In all cases a large transformer is more efficient than a small one; its percentage loss decreases faster than the dimensions increase, but the dimensions increase very slowly with the output, so that it takes a very large transformer indeed to get an efficiency of 93 per cent.—namely, about 50,000 watts.

If the figures for loss in iron here taken are very low, as seems probable, the arguments in favour of this form of open circuit transformer are very much strengthened. The loss in iron also depends on the frequency, so the higher the frequency the better these transformers are in comparison. It is curious to note that this appears to be a step backwards according to most people's ideas, and that it is also a step towards the original practice of the pioneers of transformer work—Messrs. Gaulard and Gibbs.

TABLE I.—24 hours. 2,000 periods p.m. $l=8$.

Lamps.	P. w.	S. w.	k.	b.	z.	z.	Power.		Efficiency.	c. d.	Cost.	
							Iron.	Copper.			Iron.	Copper.
2	·0087	·039	·262	2·76	1·325	1·92	14·5	8·75	84	1000	1·25	3
5	·00138	·0617	·4	3·54	1·64	2·15	25·6	19·7	87·5	"	2·25	6·75
10	·0195	·0875	·5	4·47	1·95	2·3	39·7	28	89	"	3·45	9·6
25	·0309	·138	·295	9·2	2·5	3·68	100	70	90	"	8·7	24
35	·0365	·164	·333	10·5	2·75	3·75	124	83·5	90·5	"	10·6	28
50	·0437	·195	·375	11·5	3	3·84	154	103	92	"	13·4	35
70	·0517	·231	·41	13	3·22	4·05	188	137	92·8	"	16·4	47
100	·062	·245†	·49	14·3	3·5	4·07	225	170	94	"	19·6	59
160	·078	·324†	·54	17·2	3·9	4·43	303	250	94·5	"	26·3	86
250	·0975	·387†	·6	20·4	4·4	4·62	423	325	95	"	37	112
400	·1235	·49†	·65	24·8	4·9	4·78	645	420	95·5	"	56·5	144
650	·157	·624†	·69	30·8	5·5	5·5	700	660	96·5	"	61	227
1000	·195	·774†	·73	37	6·125	6·07	1095	920	96·75	"	95	315

TABLE II.—16 hours. 2,000 p.p.m.

2	·0071	·032	·25	2·31	1·3	1·78	19·7	15·4	77·5	1500	1·14	2·3
5	·0126	·0563	·38	3·3	1·57	2·1	34	35·5	81·25	1200	2	7·3
10	·0179	·08	·46	3·8	1·77	2·15	46	49	86·4	"	2·67	14
25	·0309	·138	·295	9·2	2·3	4·08	132	84	87·5	1000	7·7	28·7
35	·0365	·164	·333	10·5	2·55	4·12	168	102	88·5	"	9·8	35
50	·0437	·195	·375	11·5	2·7	4·27	198	133	90	"	11·5	45·7
70	·0517	·231	·41	13	2·95	4·4	345	183	90·7	"	14·2	62·5
100	·062	·245†	·49	14·3	3·05	4·84	285	253	92	"	16·5	86

TABLE III.—8 hours. 2,000 p.p.m.

2	·00945	·0425	·317	2·72	1	2·72	21·3	17·8	75·5	850	·62	8·4
5	·015	·067	·424	3·72	1·265	2·84	55	28·5	78·4	"	1·6	13·5
10	·0212	·0945	·5	4·6	1·48	3·15	82·5	46·3	82·4	"	2·4	22
25	·0334	·15	·295	10	1·9	5·17	213	108	82·5	"	6·2	51
35	·0396	·177	·35	11·8	2·2	5·35	300	172	85	"	8·7	83
50	·0475	·212	·395	12·2	2·3	5·3	330	170	85·7	"	9·6	80
70	·056	·239†	·47	13·5	2·45	5·5	385	230	87·3	"	11·2	109
100	·067	·266†	·51	15·2	2·8	5·4	515	245	89	"	15	116

TABLE IV.—4 hours. 2,000 p.p.m.

10	·0225	·1	·55	4·9	1·26	3·9	163	68	72·25	750	2·3	41·5
25	·0355	·159	·33	10	1·6	6·25	347	160	75	"	5	97·5
35	·0425	·189	·36	11·36	1·7	6·65	416	209	78	"	6	128
50	·0503	·225	·41	12·75	1·9	6·7	532	250	79·5	"	7·7	153
70	·0595	·264†	·45	14·4	2·05	7	630	313	81·7	"	9·2	190
100	·071	·318†	·5	16·3	2·22	7·8	720	480	83	"	10·4	293

TABLE V.—2 hours. 2,000 p.p.m.

10	·0225	·1	·55	4·9	1·1	4·45	232	95	65	750	1·7	58
25	·0355	·159	·33	10	1·35	7·4	566	250	65	"	4·1	153
35	·0425	·189	·36	11·36	1·48	7·7	705	305	67·6	"	5·1	186
50	·0503	·225	·41	12·75	1·61	7·95	870	390	70·5	"	6·1	239
70	·0595	·264†	·45	14·4	1·8	8	1100	440	73·2	"	8	269
100	·071	·318†	·5	16·3	1·9	8·6	1310	610	76	"	9·6	373

TABLE VI.—1 hour. 2,000 p.p.m.

10	·0225	·1	·55	4·9	·91	5·4	370	160	53	750	1·35	97·5
25	·0355	·159	·33	10	1·15	8·7	930	385	53·2	"	3·4	235
35	·0425	·189	·36	11·36	1·25	9·1	1160	500	55·4	"	4·25	305
50	·0503	·225	·41	12·75	1·375	9·25	1450	587	60	"	5·3	360
70	·0595	·264†	·45	14·4	1·49	9·65	1760	750	62·5	"	6·4	460
100	·071	·318†	·5	16·3	1·62	10	2162	920	66	"	7·8	560

TABLE VII.—50-Lamp Transf. 1,000 and 50 volts. 2,000 p.p.m.

P. w.	S. w.	c. d.	Time.	k.	b.	z.	z.	Power.		Efficiency.	Efficiency at 2,000 to 100.	Cost.	
								Iron.	Copper.			Iron.	Copper.
·062	·245†	1000	24	·49	10·1	2·92	3·46	135	104	92·6	9·2	11·7	35·7
"	"	"	16	·49	"	2·67	3·8	176	128	90·6	90	10·2	44
·067	·266†	850	8	·51	10·75	2·25	4·76	286	202	86	85·7	8·4	100
·071	·284†	750	4	·53	11·2	1·85	6·05	460	240	81	79·5	6·7	146
"	·318†	"	2	·53	"	1·59	7	750	535	73	70·5	5·5	213
"	"	"	1	·53	"	1·36	8·2	1260	535	62·6	60	4·3	325

TABLE VIII.—50-Light Transformers under various Time Loads. 2,000 p.p.m.

Time.	Power.	24		16		8		4		2		1	
		P. I.	Efficiency.	P. I.	Efficiency.	P. I.	Efficiency.	P. I.	Efficiency.	P. I.	Efficiency.	P. I.	Efficiency.
24	Copper. 103	154	92	230	90	460	84·2	920	74·5	1840	60·6	3680	44·2
16	133	133	91·8	198	90·5	396	85	792	76·5	1580	63·7	3168	47·6
8	170	110	91·4	165	89·7	330	85·7	660	78·4	1320	68	2640	51·7
4	250	89	89·9	133	88·6	266	85·4	532	79·5	1064	69	2128	55·6
2	390	72	87·6	108	85·9	217	83·3	435	78·5	870	70·5	1740	58·5
1	587	60	82·3	90·6	81·6	181	79·8	362	76	725	69·6	1450	60

TABLE X.—5,000 p.p.m.

Lamps.	P. w.	S. w.	Hours.	k.	b.	z.	z.	Power.		Efficiency.	Cost.	
								Iron.	Copper.		Iron.	Copper.
1000	·195	·774†	24	·73	23·4	4	5·86	1000	690	97·2	35	237
50	·0437	·195	"	·375	7·3	1·925	3·8	141	83	93	5	28·5
50	·0503	·225	1	·41	8·1	·875	9·25	1440	420	62	2·6	257

THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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BRADFORD.

Bradford, Yorks. Such will in the future be the answer to the question as to what municipal authority first carried out, under its own auspices, a scheme of electrical distribution from a central station. To-day, Friday, Sept. 20, in the year of grace 1889, Bradford inaugurates the new scheme with a public opening ceremony, which will direct the attention of all its citizens to the good work commencing in their midst. Trial runs have, of course, been made for some time past with success, but now commences the permanent lighting, the success of which will be watched with great interest. Before describing what apparatus or system is used we may say that electricity, so far as lighting is concerned, has here to compete against gas with the latter almost at its lowest rate, thus the direct comparison is very disadvantageous to the new illuminant. When the municipal authorities decided to venture upon this work, they placed all the arrangements in the hands of Mr. J. Shoolbred, of Westminster, an engineer who has paid considerable attention to electric lighting matters since the apparatus in connection therewith became practical. After a careful attention to the peculiarities of the situation, and the immediate requirements likely to ensue, it was decided, in the first place, to adopt the direct-current low-pressure system as meeting these requirements. The first demand for the light will, it is expected, be from a comparatively near area around the station, though later on it is expected that a more distant area will have to be supplied, with a zone of less demand between the two areas.

The Corporation had a piece of spare ground near the Midland Railway Station, and upon a portion of this a convenient and substantial central station has been erected, the greater part of solid construction, the remaining part consisting of temporary attachments, to be removed when the time for extension arrives. So far as we can gather, the whole of the present scheme has been arranged to permit of any required extension with the least possible inconvenience. The ground plan of the building may be roughly described as a parallelogram, divided into four parts, the chimney-shaft being at the intersection of the diagonals. The plant, as erected, consists of a battery of three Lancashire boilers, by Holdsworth and Sons, of Bradford, generating steam for three engines, two by Willans and Robinson, of Thames Ditton, each giving nominally 150 h.p., and one by Marshalls, of Gainsborough, of 200 h.p. Each engine is geared direct to a Siemens 95-unit dynamo, which give a normal pressure, under normal conditions, of 150 volts. What may be termed the detective arrangements are well carried out, the meters showing at a glance the condition of any coil or main circuit. The dynamos run singly or in

parallel, and the four mains are so laid as to permit the use of any one for charging purposes if required; as if success attends, and attend it must, these efforts, the more distant area will ultimately be supplied by the battery-transformer system.

Besides the dynamos, Messrs. Siemens have supplied the measuring apparatus, the switchboards, the leads, and the cables. The latter are made to a specification, and partake somewhat of the character of what telegraph men call shore end cables. The copper conductor is protected by insulation by armour, lead sheathing, metal tape, etc., and it seems difficult to imagine how under ordinary circumstances it should suffer electrically or physically. Its electrical condition will be better understood if we mention that the nine miles of wire now *in situ* give an insulation resistance of 72 megohms. Messrs. Siemens's portion of the work has been carried out under the supervision of Mr. Kingston. The supply is by meter at the very low rate of five shillings per unit. The meters under test are those of Aron, Chamberlain and Hookham, and Edison, but the two former seem to find more favour than the latter.

Such then, briefly, is the first central station under municipal authority in the country. And though, no doubt, critics will be found to disagree with this and that detail, some preferring alternate current and transformers to direct currents and battery transformers, some belting to direct gearing, some locomotive type to Lancashire type boilers, some less carefully insulated mains or insulated in other fashions, on the whole the scheme has been well and carefully considered, and the conclusions arrived at only arrived at after a thorough examination of all the conditions that hold at Bradford.

We are exceedingly interested in this central station, which, although a small one, will go a long way to solve certain questions which are otherwise very difficult of solution. Here we shall get a balance-sheet that will give information, we shall know exactly what the capital charge is, and what is the cost of production and maintenance. The balance-sheets of private companies tell a tale certainly, but the tale can only be understood by supplementary information, which is never forthcoming. These public companies are so mixed up with Stock Exchange transactions, payments for patents, for promotion, etc., that it is difficult to get at bare facts of cost and production.

Another question to be solved is the manner in which the ratepayers will support their own factory. Users may have no very partial feelings towards an exploiting company, but here their support, or lack of support, means the success or failure of their own concern, and we should imagine that the man who is on the verge of giving the light a trial will

far more readily decide in favour of the municipal works than the company's.

We see, too, here for the first time a great opportunity for power distribution. The makers of motors should make Bradford a hunting ground. Every user of power should have the advantages of motor work put before him. It is certain that the Electrical Committee of the Corporation would give all the aid it could to the development of this part of the business, and with a direct-current supply, over a limited area, the conditions ought to be favourable.

THE BROOKS SYSTEM OF UNDERGROUND CABLES.

"We've got the ships, we've got the men, we've got the money too," sing the would-be patriots, and when any section of a class have got all they want they are happy. What is it we require to make electric lighting a thorough success? We have got the engines, we have got the dynamos, we have got the money, we have got the men, we are looking for the system of underground mains. Not that we are without systems, very good systems, many of them, and serving their purpose admirably. But we want a system that is eminently simple in its details, absolutely safe in its insulation, easy to lay in the ground, and as cheap as overhead wires. Can we get it, for if so success is ours, and the gas companies must shake still harder in their shoes. Can we get it? Well, we don't know; but things look promising.

Mr. David Brooks, of Germantown, Philadelphia, a veteran pioneer in electrical matters, was for a long time managing director of the telegraphs in Philadelphia. Electrical insulation was his special study, and it was he who first introduced in 1863 paraffin wax as an insulator for wires carrying electric currents. Be that as it may, Mr. Brooks was the first to use paraffin oil as an insulator. The Brooks system of liquid insulation was the outcome of his continued experiments, and he sold his American patents to the Western Union Telegraph Company for 190,000dols. cash. This system has been tried in exceptional places for both telegraph and telephone lines, with very favourable results. The system here was to employ iron pipes, in which the liquid was kept under pressure, with a stand-pipe to keep up the pressure. This, though giving good insulation, was open to objections on account of leaking, and Mr. Brooks has finally perfected his present system in which the use of paraffin oil is discarded and a very thick heavy oil is used. This oil, the remarkable insulating properties of which were discovered by Mr. Brooks, is in reality rosin oil, or rather the dregs of rosin oil after the finer quality has been driven or distilled off. It is known as "London oil," or "kidney oil"; and is a mere refuse used in making common qualities of cart grease. When prepared for use on cables it is of a clean brown colour of the consistency of very thick treacle. Its insulating powers, as will be seen, are enormous, and its cost is somewhere about 4d. per gallon. This oil is now used in the manufacture of cables, but Mr. Brooks's perfected system consists in using the insulation in a semi-liquid state, in ordinary iron pipes, with copper cables covered with the commonest quality of cotton, jute, or hemp, which, when saturated and boiled in the liquid, become highly insulated. In this way the cable is practically manufactured in the simplest manner possible upon the spot where it is to be laid.

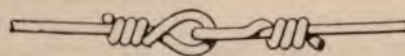
METHOD OF LAYING.

The Brooks system, therefore, consists of the employment of rosin oil in iron pipes as an insulation of copper mains, the mains being kept mechanically apart from each other or from the pipe by a covering of cotton, hemp, or jute. The pipe used is ordinary lap-welded iron pipe of a small diameter compared to those ordinarily used; that for a 7/16 cable, or even a 19/20 cable, not being more than 3/4 in. inside diameter. Larger pipes, of course, can be used

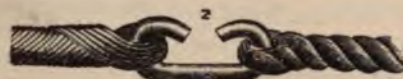
as the number or size of the cables increases, but in any case the mains or conduits are comparatively small. The pipe is jointed together in the usual way, but having tee-joints instead of the ordinary union-joints. These tee-joints are furnished with a small plug which is screwed into the top, or unscrewed to allow of the insulation being poured in. Every hundred yards or so, as desired, a main splice box, of the shape shown in the illustration, is inserted, for tapping off wires or effecting junctions. These, by the way, should be placed under the pavement between two cross streets, and not at the intersection where the double traffic from the two streets interfere with the men working. They are also better to be near the surface, to save the necessity of manholes. A small trench having been dug, the pipes are laid, carefully jointed with red or white lead to make watertight junctions, and each pipe as it is laid is threaded over a telegraph wire, which is pulled through piece by piece to serve as a hauling medium for the cable. Where necessary, this wire is carefully jointed and twisted together, not in the usual way, but as shown in the cut, to leave the ends clear against catching in the joints of the pipe. The pipes themselves are scoured out to get rid of accidental projections, and the ends where the cable is pulled in are reamed off to prevent cutting of the jute or other covering. The pipes are laid to lengths of 500ft. to 1,000ft. for one length of cable; the pipes are measured, and the cable is cut off to fit the length. The lengths, of course, vary to suit the streets. While the pipes are being laid a special cauldron on wheels is taken to the splice-box. The



Splice Box.



Joint for Iron Wire.



Drawing-in Cable.



"Brooks" Main, full size.



"Brooks" Mains in zin. Iron Pipe, with tee-joints.

drum of copper cable, already coarsely wound with cotton and jute, is mounted on this, and the cauldron is filled with the rosin oil. The whole is raised to a temperature of 360deg. F., and boiled for some time. Bubbles rise after the temperature of boiling water, 212deg., is attained, any moisture contained on the covering being thus driven off. During this time the end of the cable is bared, lapped over on itself in a smooth joint, as shown, so as not to catch in the pipe. When no more bubbles arise the cable is pulled through the pipe, a gallon or two of ordinary paraffin oil being first poured in to lubricate the pipes. The pulling can be done by means of a winch at the other end, or by means of horses. The speed of pulling varies, of course, with the means at disposal; but figures are given to show that at Brooklyn, where the telephone cables were laid on this system, a length of 500ft. was pulled by two men with a winch in 20 minutes, or with horses, without a winch, 520ft. was pulled through in five minutes. The hot cable is handled by tongs; even if it is raining it does not affect the insulation, as the drops, if they touch the cable, are instantly turned to vapour.

When the cable is pulled through, the cauldron is wheeled along to each joint, and the boiling oil is poured into the plug-holes, filling up each length of pipe one after the other. The splice-boxes are made of malleable iron, with screwed covered lids; they are made in sizes of 8in., 10in., and 12in. diameter.

The joints of the cable are made in a very simple and easy manner. The ends of the two cables are separately twisted together, wire by wire, the ends sticking upwards. The wires are then fitted with a little insulating sleeve,

which is slipped over each joint, and the whole then covered with the hot oil, and the cap of the box screwed down tight.

COSTS ONE-THIRD OTHER SYSTEMS.

This is the description of the method, which, according to Mr. Brooks, is three times less expensive than ordinary underground systems, and, in fact, so he maintains, is actually cheaper for telegraph or telephone wires than overhead work. Other systems require, first of all, a conduit, and this alone costs twice as much as it does to lay all the wires that the conduit can be made to hold; or else they require expensively insulated cables, which, after all, are liable to fail, owing to coiling and uncoiling in drawing them in.

ADVANTAGES OVER OTHER INSULATION.

Two very important incidental advantages are inherent in this system; first, the insulation being liquid is always in a slight state of movement from the contraction or expansion of the pipes by alteration of temperature. This leads to the result that if accidentally a pinhole was caused, for instance, by lightning, the hole, instead of becoming worse and worse (as would be the case with ordinary insulation under the continued action of the current), becomes, on the other hand, almost immediately filled up, and the insulation thus tends to keep perfect. An instance of this was seen in a cable in America struck by lightning which showed an earth. Next morning the wires tested as perfect as before. The fault had been made good by the moving oil. The second advantage is that the rosin oil is

both water-repellent and heavier than water. The result of this is that once the moisture is driven out of the insulation, no moisture from the outside can reach the covering, and also that if any water did get into the pipe it would simply rise to the top.

A cable has been laid, about two years ago, on this system for the Pennsylvania Railroad Company. It contains 53 conductors for telegraphic purposes, and is about 1½ miles long, 1,500ft. being in a ditch covered with running water, the remainder suspended in the air among the braces of the bridge. It contains 18 splices. The insulation as tested by Prof. Otto Kendall gave an average insulation per mile of 4,102 megohms at a temperature of 50deg. F. They were tested afterwards by Mr. R. W. Jaggard, electrician, to an insulation of 16,913 megohms per mile, at a temperature of 25deg. F. They have worked remarkably well, and no interference has been felt. This has been all the more remarkable as nearly all underground lines in America suffer more or less from the effects of lightning. The following letter from the Pennsylvania Railroad Company was quite recently given to Mr. Brooks immediately before his departure for England:

Pennsylvania Railroad Company,
West Philadelphia, July 5, 1889.

MR. DAVID BROOKS, SEN.,

Dear Sir,—In reply to your favour we have nothing to report, except confirming those of Dr. Cresson, Prof. Herring, Mr. Griffin, and others. Every conductor is in perfect condition, and none have been interrupted by the electrical storms which have been so prevalent.

Yours truly,
H. FONDERSMITH,
Division Operator.

ACCOUNT OF EXPERIMENTS AT CHARLTON.

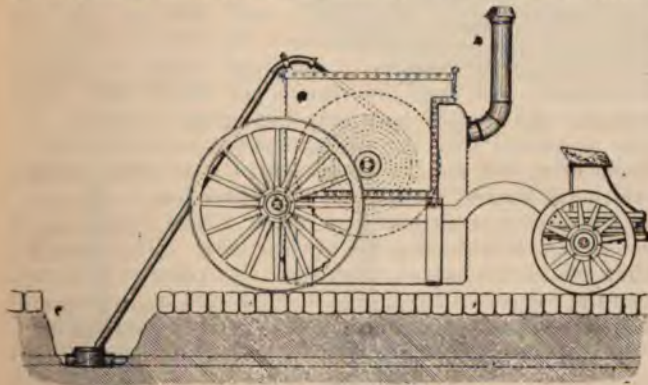
On Monday last we were invited to see some experiments with the Brooks system at the works of Messrs. Johnson and Phillips, at Charlton, Kent. In order to have results which appeal to the practical engineer, it would be desirable to have, not fancy or scientific tests only, but those such as would indicate the value when (1) in actual use, and (2) after some years' work. The first condition was at any rate to some extent reproduced at Charlton, where the Brooks cable was run for the length of some 140 yards underground with two joints and a splice-box. The second condition it is obviously impossible to reproduce, but it is equally obvious that a system of liquid insulation, which will fill up faults if occurring, is more likely to stand the test of time than that of solid bodies, in which pinholes or cracks from bending would start faults, afterwards developing into short circuits or earths. At any rate the oil improves rather than deteriorates in its quality by age,



Splice Box Open.

if we may take the word of a manufacturer of whom Mr. Brooks has carefully enquired. In actual work it has been noticed that after some time the insulation test improves.

We will now give the result of the tests undertaken at Messrs. Johnson and Phillips. The cable was a seven strand No. 16 copper cable, each wire being insulated separately for telephonic or telegraphic purposes by a thin double covering



Method of Laying the Brooks Underground Mains with Canldron of Hot Rosin Oil.

of cotton, and the whole braided to a thickness of $\frac{1}{2}$ in. diameter by jute. This had been drawn in hot, in the manner described, into a $\frac{3}{4}$ in. iron pipe, which was led from the office along a trench underground to the works across the railway. A delicate reflecting galvanometer was used, resistance 12,500 ohms: the constant = 1.24 megohms, and a shunt of 10 ohms was employed. The battery was 200 Leclanché cells.

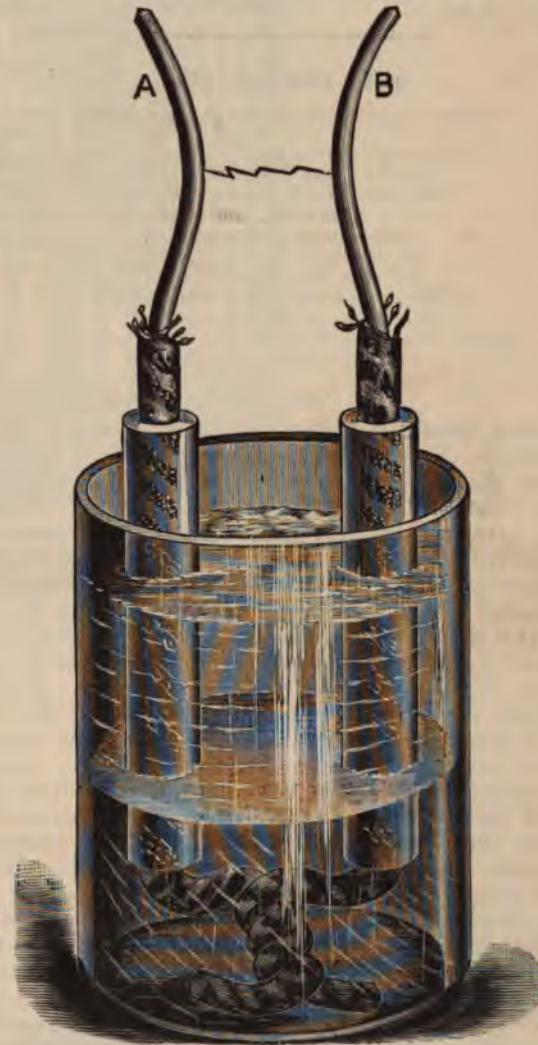
1. The wires were all freed at each end: one wire was attached to galvanometer and given an electrification of one minute duration. Deflection = 15deg. A second wire was then taken, and showed the same result. The resistance calculated from this was 3,090 megohms absolute for the 140 yards. This is the insulation resistance to earth through the pipe.

2. Next, all the wires except one were connected together and to earth, and three tests were taken. Resistance of the other wire to these—deflection (a) 19deg., (b) 17deg., (c) 19deg., after one minute. Result, average insulation

resistance to other wires and earth of 2,440 megohms. (Note.—Deflection after one minute still falling rapidly.)

3. All the wires bunched, insulation resistance to earth: deflection 52deg. Result, 890 megohms, or average each of 6,230 megohms. (Note.—Tested together, the average insulation resistance is always higher than separately.)

4. A most interesting experiment was next undertaken. It must be remembered that this cable was a telephone or telegraph cable, with thin insulating material. A Kapp converter was connected to an alternate current machine of 100 volts, transforming up to 1,000 volts. The wires were led to a series of ten 100-volt lamps, which were brought to a full glow. The ends of the series, at the pressure of 1,000 volts, were attached to two wires of the cable, and maintained at this pressure for some five minutes without flicker to the lamps or apparent harm to the cable—a steady stress of 1,000 volts alternating current on two wires of a thinly insulated telephone cable.



Insulation Test of Brooks Cables.

5. The cables were then tested with an induction coil to a pressure probably of 170,000 volts. An ordinary iron pail was filled with the insulating material. In this had been inserted two pieces of the same cable with their ends twisted closely together underneath the insulation, and their other ends sticking out of the insulation at a distance of eight or nine inches. The arrangement is represented in the accompanying illustration, which shows a glass vessel containing the insulation covered by water. The terminals of a long induction-coil, specially sent from Mr. Apps, Strand, were attached to the two wires, and the current turned on. Flashes flew in all directions to the sides of the pail, and it is interesting to mention that the pail was guarded with sheets of pure rubber of double and treble thickness, but the sparks pierced these, commonly regarded as thorough insulating materials. A piece of window glass was at last inserted to stop the sparks flying to the pail. Finally, when the tops of the cables were brought to the distance of $7\frac{1}{2}$ in., the

induction flashes sparked across the distance continually through the air, without breaking through the insulation of the twisted cables below. This distance corresponds to a pressure, according to the list published by Profs. De la Rue and Müller, of between 163,000 and 186,000 volts. The cables were afterwards tested for insulation, and found perfect.

6. Afterwards a further piece of 100 yards of 7/16 cable, just laid, was tested in the same manner as those above, and gave as a result an insulation resistance equal to 9,240 megohms per mile.

These most interesting and conclusive experiments were witnessed by several representatives of the technical press, of the Post Office and the telegraph companies, as well as by Mr. Kolle, engineer to Mr. S. Z. de Ferranti, who expressed himself very much pleased with the results shown. The system is being worked in England by Messrs. Johnson and Phillips, of 14, Union-court, E.C., and Charlton, Kent.

NEW YORK NOTES.

(FROM OUR SPECIAL CORRESPONDENT.)

The Postmaster-General and the Western Union.

Proposed Postal Telegraph Scheme.

Dr. Green says it would not work.

The "Electron."

Another Death from Electricity.

Mr. Harold P. Brown's Letters.

His Office was "Burglarised."

\$1,000 Reward and a Dark Insinuation.

More Trials for the Subway Users.

Electric Cars; they Save Lives and Save Pavement.

Electricity v. Sand.

NEW YORK, September 6, 1889.

Nothing definite is known as yet about the proposed reduction in the rate for Government messages, but it is believed that the question has been settled satisfactorily for the Western Union; Mr. Jay Gould and Dr. Norvin Green have recently held various consultations with the Postmaster-General with a view to bringing that official to see the error of his ways. At one of these meetings, Mr. Wanamaker hinted at a postal telegraph scheme, his idea being that the Post Office should undertake the collection and delivery of telegrams with a view to lessening the terminal expenses, and so reducing the rates. A good deal has been said by the daily press on the subject of Mr. Wanamaker's latest idea, and the general opinion seems to be adverse either to the control of the telegraphs by the Government (of which this proposal is looked upon as a forerunner), or a partnership between the Post Office Department and the telegraph companies. It appears, however, that all this is premature, as Dr. Green yesterday stated that no negotiations had been opened between the Post Office and the companies, and that none were possible until an Act of Congress had been passed authorising the Postmaster-General to enter upon them. Mr. Wanamaker's idea is not confined to the delivery of telegrams by Post Office officials, but extends to the connection of a great number of outlying post offices by telegraph, the wires to be supplied by the Western Union and operated by the Post Office, the company to be paid for the use of the wires by a percentage of the receipts Dr. Green vetos the whole business. He does not think that the delivery of telegrams by postmen is practicable. He considers that the proposed postal telegraph offices would not pay expenses, and that the service would be inferior, and sums up the whole scheme as unfeasible for the present. Probably he thinks for the future also.

A large electric launch called the "Electron" recently made a successful maiden trip of some seventy miles. The "Electron" was built by a well-known boat-builder of Newburgh, the motor and switches were constructed by the Electro-Dynamic Company, of Philadelphia, and the accumulators were supplied by the Electric Accumulator Company, of New York. The "Electron" is built of sheet-iron plates $\frac{1}{2}$ in. thick, and she measures 36 ft. over all. There is a flush deck, with a roof amidships, which provides a roomy deck-house. The motor is of series pattern, and is designed to take 70 amperes of current at 200 volts pressure. The maximum speed is 1,000 revolutions per

minute. The screw is 18 in. in diameter. The shaft of the screw is coupled direct to the spindle of the armature, forming a rigid shaft. To run the motor there are 200 cells of the Electric Accumulator Company's newest type of motor cell. The normal current given by the accumulators is 50 amperes at 200 volts, and at this rate of discharge they last for six hours. The 200 cells weigh four tons; they are placed in the bottom of the boat and under the seats, and can easily be got at for inspection. By means of a switch in the pilot-house the grouping of the cells can be changed and the current delivered to the motor at 200, 100, or 50 volts, the speed of the launch varying correspondingly, it being twelve, seven, or three miles an hour according to the E.M.F.

Another death from electricity occurred in New York a few days back. The superintendent of construction of an electric lighting company was mounted upon a ladder making some changes in a switchboard; he held a live wire in one hand and was about to secure it to a terminal when the ladder slipped, and he caught hold of a bar of the switch, thus completing a circuit through his body. He was thrown to the floor, and when picked up was unconscious, and although two doctors spent a couple of hours endeavouring to restore animation their efforts were in vain. The fatal wires carried an alternating current, and the pressure is stated to have been 1,000 volts. It is curious to note that about six months ago an employé of the same company received a shock from a wire carrying a current of 2,000 volts pressure, but was not seriously hurt; he said that it felt like being struck with a club.

The subject of Mr. Brown's letters has come up again. When the letters were published Mr. Brown was enjoying a little holiday, but he at once returned to New York, and found that his office had been invaded and his desk opened. Someone had inserted a piece of paper in the lock which prevented the drawers from being automatically fastened when the top was pulled down. Mr. Brown was naturally most exceedingly angry, and conferred first with his friends of "electrocution" fame, and then with the Attorney-General. Three days ago an advertisement appeared in a morning paper, signed by Mr. Brown, and offering 500dols. reward for information sufficient to lead to the discovery and conviction of the thief, and 500dols. for the return of the stolen documents. Mr. Brown says that the letters, as published, contained many inaccurate statements, and that the manner in which they were selected and printed had done him great injustice. He also insinuated that the matter was not got up in a news paper office, but was the handiwork of a concern between which and himself there is not much love lost.

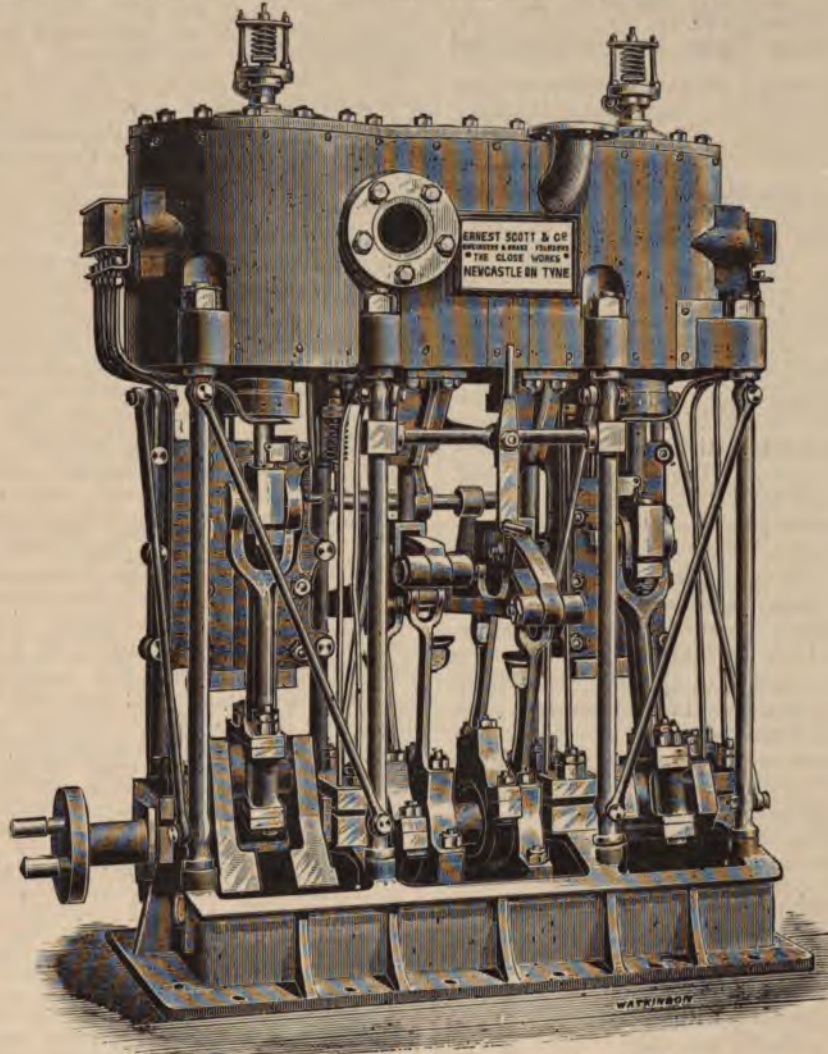
The electric companies have rather a hard time of it in connection with the disposal of their wires. The wires are chopped down wholesale from their airy position overhead, and the companies have to go underground into costly and intricate subways, out of which they are periodically blown by explosions of accumulated gas. Now the Commissioner of Public Works swoops down with a list of streets which are to be repaved, and sternly dictates that all underground work in those streets must be done at once and for good, as in no case will it be permitted to take up the new pavement unless for repairs, and then only in the event of most absolute necessity. New York has long been the worst paved city in the world, and subways have not tended to improve matters, so, perhaps, the commissioner is not ill-advised in making a hard and fast rule.

It appears that it is safer to be run over by an electric car than by one drawn by horses. A few days ago a man was knocked down by a car on the Madison-avenue line, and, falling under the car, was pushed a distance of several yards by the fender carried to protect the motor; he was not seriously hurt, but if he had got under a horse-car the wheels would have gone over him, and he would probably have been killed. The company owning the Madison-avenue line is about to be sued by the city for the cost of repaving the roadway between the rails on a section of the street which is being repaved. One of the points made by the company in denying liability to pay is that the electric cars do not wear out the pavement, and as they are adding new ones to the rolling stock at the rate of two a week, in the course of a

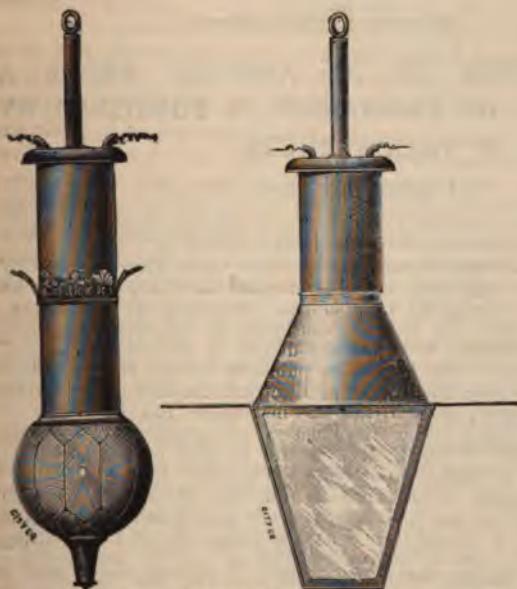
year horses will be entirely replaced by electricity, and the pavement will be everlasting, as far as they are concerned.

Some interesting experiments involving the application of electricity to increase the tractive power of locomotives,

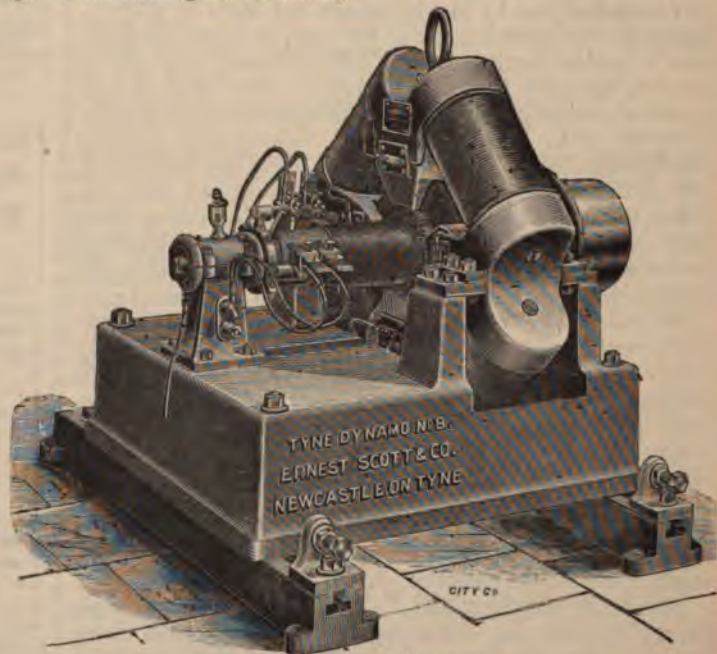
claimed to be superior to those obtained by the use of sand, and enables the locomotive to draw a much heavier train, without regard to the condition of the track, than is at present possible. With the dynamo running, a locomotive drew a train of 45 trucks.



Ernest Scott and Co's Engine at the Birmingham Exhibition.



The "Tyne" Arc Lamp.



The "Tyne" Dynamo.

have been carried out on the Philadelphia and Reading Railroad, at Reading, Pa. A small dynamo and engine were mounted on the locomotive and the current passed through the driving-wheels and the rails. The passage of the current through the wheels causes an increase of friction between the wheels and the rails, the results being

MESSRS. ERNEST SCOTT AND CO.'S "TYNE" DYNAMO AND ARC LAMPS.

Messrs. Ernest Scott and Co., of the Close Works, Newcastle-on-Tyne, show on their stand at the Birmingham Exhibition and in the dynamo-room a new type of dynamo,

to which we alluded in our report of the exhibition, and of which we now give an illustration. Messrs. Scott and Co. have named this the "Tyne" dynamo, and it is used by them for supplying several of their "Tyne" arc lamps, also of novel construction, for lighting one of the bays.

The machine has been designed by Mr. Mountain and is now their adopted type for all sizes, from three units upwards, and it will be observed that the machine is of the four-pole type, four magnets being arranged around the armature parallel to its circumference. The four magnet bars are of soft annealed wrought iron, and are joined together by four cast-iron shoes; two of the pole shoes on the horizontal line are made in halves and bolted together, enabling the top half of the machine to be lifted off and the armature taken out. The magnets are carried on a massive cast-iron bedplate with four projecting standards, which keeps the bottom of the pole shoe slightly above the floor level.

The armature is of the disc type, but of large sectional area compared with its diameter, and is wound with a simple layer of rectangular wire. In the 15-unit machine shown at Birmingham there are 60 sections of four turns each, the wire being $\cdot 16 \times \cdot 14$ section. The spindle is of steel, with thrust collar to take up end play; the bearings are of cast iron, with adjustable keeps, and lined with brass shells fitted with white metal. This construction has been adopted in preference to the ordinary method of running white metal into cast shells, and enables new brasses to be fitted in at a moment's notice, it not being necessary to heat the bearing to melt out the metal. The white metal itself is of special quality, made by Messrs. Ernest Scott and Co. for their marine and other high-speed engines, and is found to have double the wearing qualities to any other metal in the market. The commutator is of drawn copper insulated by mica and mounted upon gunmetal sleeve, connected to the spindle by lock nuts and a feather. Owing to the powerful magnetic field of these dynamos and the small resistance of the armature, the shunt machines are practically self-regulating.

Throughout the construction of these dynamos Messrs. Ernest Scott and Co. have endeavoured to combine thoroughly good electrical qualities with high mechanical efficiency, and as an evidence of this it will be observed that the machine runs splendidly without sparking or wear on the commutator and perfectly smoothly.

The "Tyne" arc lamp used for lighting the bays has also been designed by Mr. Mountain and feeds by gravity. The upper carbon-rod is cut in the form of a rack and gears into a pinion carried on a spindle running in a sliding block in the inner frame of the lamp. This block is free to move vertically, and on the outside are two brake wheels. Upon the brake wheels there is a rocking lever carrying two friction-chains. One end of the lever carries the iron core of the solenoid, and the other end the air dash pot. When the lamp is in its feeding position the sliding block rests on two adjustable stops, and as the current weakens in the solenoid the core is slightly lowered, releasing the friction-chains and allowing the carbon-rod to descend.

In practice it has been found that these lamps work perfectly well in moist or damp atmospheres, and that they will stand any amount of knocking about, and are thus eminently suited for all classes of arc lighting, and especially for factories or mills where they are subject to rough usage. The lamp is made in two types—viz., the globe, as shown at the Birmingham Exhibition, and the factory type, with square lantern and reflectors. An adjustable resistance coil for adjusting the E.M.F. at the terminals of the arc lamps is also shown in the engine-room, and is of substantial and simple construction.

Messrs. Ernest Scott and Co. also show a magnetic separating machine for extracting iron turnings from brass borings. The machine may also be used for extracting magnetic ores if required. The one exhibited is a model, the actual machine being made in three sizes, capable of cleaning from 28 cwt. of swarf downwards. The action of the separator is as follows: A circular disc studded with electromagnets revolves with its face lying horizontally over two endless bands, the bands running side by side. The brass turnings containing the iron are fed on to one of the bands and pass under the sur-

face of the disc, carrying the electromagnets which revolve, the iron particles being extracted afterwards and carried round. As soon as the magnets, which previously covered the endless bands carrying the brass turning, have revolved round to the other endless band, the current is broken by means of a commutator and the magnets become demagnetised, the iron is dropped off on to the band, and fed into a box for collecting the iron. With this machine it is possible to collect practically every bit of iron out of the brass, and as a proof of the excellence of these machines we may state that Messrs. Ernest Scott and Co. have already supplied one to both the Royal Arsenal and Chatham Dockyard. The machine is provided with suitable adjustment in all directions, and the current is supplied by a small dynamo also made by the firm.

A set of launch engines are also exhibited, with cylinders $6\frac{1}{2}$ in. $\times$ $11\frac{1}{2}$ in. $\times$ 8 in. stroke. These engines are designed for small vessels requiring light, first-class machinery, and are capable of running at a high speed, and, as a matter of fact, during their test they ran at over 700 revolutions per minute, but when the speed was reduced to 400 revolutions per minute they indicated 100 h.p. The standards, bedplate, connecting-rods, piston-rods, and all moving parts are of steel and white metal, and provided with continuous lubricating arrangements.

The duplex Admiralty type pump is also exhibited. This is of the Admiralty No. 3 size, with two steam-cylinders, $4\frac{1}{2}$ in. diameter, water-cylinder 3 in. with a 5 in. stroke. The firm manufacture these pumps in six sizes, and make a speciality of them. A casting of a fan vane is also exhibited, and is a very fine specimen, the fan being absolutely in balance and the thickness of the casting throughout being slightly over $\frac{1}{2}$ in. Messrs. Ernest Scott and Co. have in many cases supplied gunmetal fans, and they find that the cost is only slightly more than a built fan, and they are far more satisfactory in running.

Messrs. Ernest Scott and Co.'s foundry, which is the largest on the Tyne, is capable of producing gunmetal and brass castings up to 10 tons weight, as also the lightest and finest work that is required. The firm make a speciality of gunmetal castings for warships, made of Admiralty mixture of metal, and supply many of the largest firms in the district.

Round the stand Messrs. Ernest Scott and Co. show photos of marine engines, torpedo boat engines, hydraulic pumps, and other machinery which they manufacture. They are now devoting a considerable amount of attention to electrical machinery, and this department is developing considerably.

PRECAUTIONS TO BE ADOPTED WHERE A SUPPLY OF ELECTRICITY IS FURNISHED BY MEANS OF TRANSFORMERS.*

BY KILLINGWORTH HEDGES, M.I.C.E.

In a paper entitled the "Fire Risks of Electric Lighting," which was read at the meeting of the British Association held in Southport in 1883, I brought forward for the first time the necessity of electric light regulations and the use of safety appliances. The fire insurance companies have almost universally recognised that the electric light can only be considered a safe illuminant when the strictest attention is paid to the details of an installation; and the regulations which have been published by the principal companies and by the Institution of Electrical Engineers have so far proved successful, as no fire of magnitude can be traced to the electric light. The introduction of transformers has led to the increase of the E.M.F. in the primary mains, and there appears to be a tendency to decrease the pressure in the secondary, consequently there is an enormous difference of potential between the two systems and a constant strain on the insulation of the transformer. A transformer may be compared to the reducing valve which converts high-pressure steam into the safe pressure for working heating coils. There is, however, this difference—a transformer never sticks like a valve, but it sometimes leaks, and the consequences are similar to those arising from a leaky reducing valve. Supposing a small leak to take place between the primary and secondary coils. It is quite possible that a small current of dangerously high potential might be introduced into the secondary circuit, which would make very little difference to the light from the lamps, but might cause fatal results on anyone inadvertently touching some unprotected portion of the wires or fittings with

* Paper read before Section G of the British Association at Newcastle.

one hand and a gaspipe with the other. To produce this effect it is necessary that some earth should occur on the primary main or mains. With the overhead wires, which have almost universally been employed with alternating currents of high E.M.F., any leakage to earth may be avoided, but with an underground system, and with the increased pressure which is about to be introduced, there is sure to be some earth connection; in fact, with the Ferranti system, one of the conductors is to be earthed throughout. Allowing that a possible danger exists, the question is to find a safe preventive, and with this object it is proposed to briefly recapitulate what has been done. Mr. Kent inserts a metallic shield between the primary and secondary coils of the transformer; this sheet of metal is connected to earth. Now, if the insulation of the primary coil should fail, the leak before reaching the secondary coil must pass through the sheet of metal and thus to earth, causing the primary cut-out to melt and thus cutting out the faulty transformer. The next plan is still simpler, and is to earth the secondary circuit, so that the effect of a contact in the transformer would be to establish connection through the earth and to blow out the primary fuse as in the previous method. It has been stated by several high authorities that this arrangement is all that is wanted to secure perfect safety against shock, but the question of fire risks has also to be considered, and these would be greatly increased, also the insulation of the wires in houses would have to be of the most expensive character. Allowing that every care had been taken with the insulation, the proximity of gas and water pipes in a house to the wires, which are often laid under floors, might open a path for the deviation of a leakage current, say, of 2,000 volts or over, and an arc once formed would result in a dangerous fire. The fire insurance offices have not sanctioned this plan, which does not even appear to be used in those go-ahead institutions, the electric light companies of the United States, who apparently employ no safeguards, and trust to Providence with regard to the "burn out" of a transformer, having a ready supply of duplicate parts to at once replace in the faulty instrument. We now come to the intermittent earth device—that is, the automatic apparatus which only comes into play when the potential in the secondary has dangerously increased. Dr. Fleming has described an instrument which consists of a fine wire safety catch holding down suitable contact pieces in mercury cups against the pressure of a spring. The safety catch would be arranged to stand the normal difference of potential between the two secondary mains, but as soon as that rose beyond a certain amount, the circuit would be automatically broken. This plan has the disadvantage of a certain amount of loss of current, which would be, however, checked by a resistance, but it avoids the necessity of using an earth. Dr. Bernstein advocates his contact plug, which contains a substance, the resistance of which can be made enormous with the normal current, but the heating effect of an increasing current causes the mixture in the plug to be decomposed, and a metallic circuit established. I am unaware whether this has been tried in a circuit from a transformer or not, but am afraid it would not answer in practice. Major Cardew, whose improved apparatus I have the pleasure of showing you to-day, has, so far, produced the most successful device. It has been called the static mousetrap, in that it goes off directly an unauthorised volt enters it. The arrangement which you see on the table takes the form of a box; in it there are two brass discs, separated one from the other by an insulating washer of ebonite. Between the two discs is placed a small strip of aluminium foil which lies in ordinary on the lower disc, which is connected to earth. The other disc is in connection with the secondary coil of the transformer, and should any leakage take place from the primary so as to raise the potential in the secondary, say, by 50 per cent., that part of the aluminium foil which is under a projection on the upper disc will be attracted to it, making an electrical connection and starting an arc which short-circuits the secondary and causes the primary fuses of the transformer to be melted. Working quite distinctly from Major Cardew, I have also designed a safety appliance which may be called a "vacuum cut-out." It is on the lines of those lightning-protectors which are often used with telegraph cables, but the electrodes are fixed at each end, and cause the current on its way to earth, after leaping across the points, to energise an electromagnet which releases a short-circuiting device connected with the primary poles of the transformer. There is one great advantage in my vacuum cut-out, in that it is not affected by dust or moisture, which might impede the static arrangement. In practice, I propose using old incandescent lamps, with their broken filaments sprung, as they often are, one-sixteenth apart. The perfect vacuum must, however, be destroyed, or only high potential will pass, and the current will preferably short-circuit across the terminals, instead of leaping across the broken filament. A lamp of this description would cost very little, and could be fixed in the same manner as the Cardew cut-out, without any relay. Numerous experiments were made to ascertain the distance which an alternating current would leap across points in tubes exhausted to a certain amount. The results differed considerably from the figures given by De la Rue in his experiments with continuous currents. In one experiment with glass cylinders having conductors hermetically sealed in opposite ends, and with a pressure of 5m/m., less than that equal to an ordinary vacuum, an alternating current of 1,000 volts invariably passed between the ends of the copper electrodes, which were 3in. apart. The arc, however, did not remain steadily at the ends, but would first run down one electrode to the point where it was connected to the platinum wire, which came through the glass, with the result of fusing it away. The arc would at the same time extend almost to the glass, although the opposite electrode was left intact. The reason for this phenomenon with an alternating current may be perhaps explained in the discussion. In conclusion, I think that all those who intend using high-tension alternating currents, for the supply of electric light and power, should be obliged to fix a safety device on the secondary circuit, near

the transformer, with the object of not only protecting their own property, but also to do away with the possibility of an unauthorised current being inadvertently led into a building so as to endanger the lives of the public.

ON THE E.M.F. PRODUCED BY AN ABRUPT VARIATION OF TEMPERATURE AT THE POINT OF CONTACT OF TWO PORTIONS OF THE SAME METAL.*

BY HENRY STROUD, M.A.

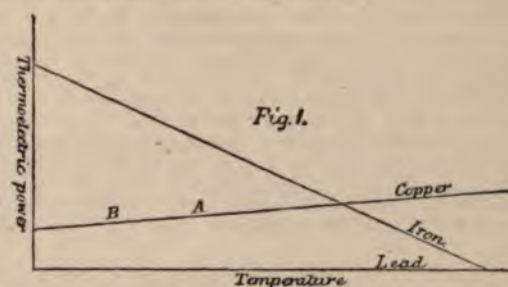
According to the law of Magnus (1851) no thermo E.M.F. can exist in a circuit consisting of one metal, homogeneous in structure, provided there is no discontinuity of form nor abrupt variation of temperature.

Le Roux (1867) performed a number of experiments, showing that a thermo-electric current is produced in a single metal whenever there is dissymmetry with respect to the point of heating.

Ritter in 1801, and others since, have obtained currents by bringing hot and cold wires in contact, and Franz and Gauguin have pointed out that the effect depends on the state as to oxidation of the surfaces of the metal experimented upon. Some experiments were made by Durham (1871) on the momentary current developed when two platinum wires were brought into contact, the wires being at different temperatures, and he found that the momentary current was proportional to the difference of temperature.

No experiments appear to have been made on the E.M.F. produced when two portions of the same metal are in contact, and the one portion is kept at a high temperature and the other kept at a low temperature. The results of such experiments can be predicted from the thermo-electric diagram, and, conversely, a simple and direct method may thus be obtained for the determination of the Thomson effect. It was with the view of developing this method, which was suggested by the thermo-electric diagram, that the experiments described in this paper were undertaken.

From the thermo-electric diagram, which represents very clearly the researches, theoretical and experimental, of Sir W. Thomson and of Prof. Tait, we should expect the E.M.F. produced at the point of contact of hot and cold portions of the same metal to be in one direction for those metals for which the Thomson effect is positive, and to be in the opposite direction for those metals for which the Thomson effect is negative. Copper is a good example of the former, and iron of the latter. In the case of lead, for which Le Roux found that the Thomson effect is inappreciable, we should expect no E.M.F. Moreover, the E.M.F. should be greater, under similar circumstances, the greater the magnitude of the Thomson effect.



In Fig. 1 we have represented the iron and copper lines of the thermo-electric diagram, with lead as the metal of reference. If copper, kept at a high temperature, indicated by position "A" in the diagram, is placed in contact with an identical copper conductor, kept at a low temperature, indicated by, say, position "B," we should, it seems to me, expect an E.M.F. to be established from hot to cold, seeing that the Thomson effect in copper is positive; or, in other words, since an electric current flowing through a copper conductor, in which there is a gradual fall of temperature in the direction of the current, has the effect of reducing the differences of temperature, we should expect the contact of hot and cold copper to give rise to an E.M.F. which would be in such a direction as to tend to reduce the difference of temperature—i.e., from hot to cold. Similarly, if two identical iron conductors are placed in contact, the one being kept hot and the other cold, we should expect analogous results; but the direction of the E.M.F. would be opposite as the Thomson effect is negative.

The greater the slope of the line representing the metal in the thermo-electric diagram the greater we should expect the E.M.F. to be for a given difference of temperature, for the difference between the thermo-electric powers corresponding to the two temperatures is proportional to the tangent of angle of slope. To find the relation between the E.M.F. and the difference of temperature constitutes part of this investigation. The E.M.F. will be proportional to the difference of temperature in case it is proportional to the difference of the thermo-electric powers corresponding to the two temperatures; for this difference, from the diagram, is represented by

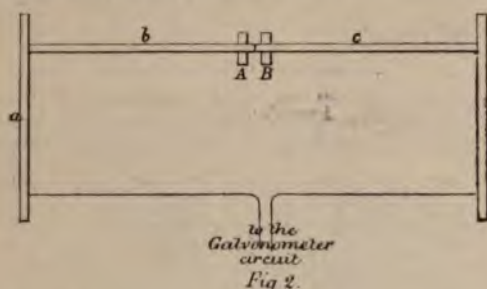
(difference of temperature) $\times$ tangent of angle of slope.

Hitherto the experiments made have been chiefly with copper and iron—two typical metals.

From preliminary experiments it was found necessary that the physical condition of the metal experimented upon must be identical

* Paper read before the British Association at Newcastle.

throughout the portion of the circuit in which the abrupt difference of temperature was produced, otherwise the thermo-electric E.M.F., due to heterogeneity, quite masked that due to the cause in hand. This condition was satisfied by dividing a tube of the experimental metal, cleaning the surfaces with sand paper, and pressing the similar portions together, a mark on each portion of the tube enabling this to be done very exactly. The surfaces were carefully rubbed down so that good contact was obtained between them when pressed together. The preliminary experiments also showed clearly the necessity of keeping the surfaces in contact free from oxide; the surfaces were therefore cleaned before each experiment.



In the adjoining figure (Fig. 2) is represented the arrangement that has been found suitable. Between the two tubes *a* and *d* were placed the two tubes *b* and *c*, which were pressed together and kept in contact with each other and with the tubes *a* and *d* by means of a spring. *a*, *b*, *c*, *d* were all cut from the same length of tubing, and the ends of *b* and *c* in contact were adjacent portions before cutting. To the ends of the tubes *a* and *d* were soldered the copper or iron wires, which were connected to the galvanometer (a low-resistance Thomson), and in the circuit was included a wire which had a resistance of 0.554 ohms. At the ends of this wire was established, by means of a Leclanché cell and an adjustable high resistance, an E.M.F. of such a magnitude as to balance the thermo-electric E.M.F. The contacts of the tubes *a* and *d* with *b* and *c*, and with the soldered wires were kept at the same temperature by means of a constant current of water flowing through the tubes *a* and *d*, which were connected by an indiarubber tube not shown in the figure.

"A" and "B" are two jackets round the adjacent ends of the two tubes *b* and *c*, by means of which the one end can be kept hot and the other cold. A current of steam was used to produce the high temperature, and cold water for the low temperature. "A" and "B" were usually about half an inch from the ends of the tubes.

The temperatures of the surfaces in contact were approximately determined by means of two iron-german silver junctions, which were placed in small holes drilled as near as possible to the surfaces in contact, the hot junction being bare, while the cold was prevented from touching the metal (and so short-circuiting the E.M.F. to be measured) by means of a small indiarubber tube. It was previously verified that the E.M.F. in this subsidiary temperature circuit was proportional to the difference of temperature of the junctions, and it was found that it = 23 microvolts per degree difference.

Experimenting with $\frac{3}{16}$ in. copper tubes an E.M.F. was established from hot and cold across the junction, showing that the Thomson effect is positive. The magnitude of the E.M.F. was for one experiment, for which the abrupt difference of temperature at the surface in contact was approximately estimated at 30 deg. C, 6.0 microvolts when "A" was hot and "B" cold, 5.4 microvolts when "A" was cold and "B" hot.

It should be stated that before dividing the tube, of which *b* and *c* formed parts, a similar experiment was made, but no E.M.F. obtained, showing that it is to the discontinuity in the temperature gradient rather than to the steepness of the gradient that the E.M.F. is due.

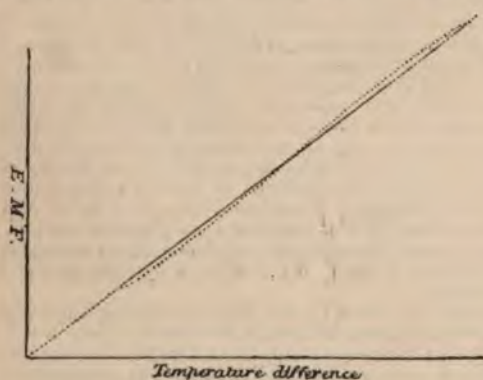


Fig 3

Similar results have been obtained with $\frac{3}{16}$ in. iron tubes, no E.M.F. being obtainable when the tube is entire; but on division an E.M.F. from cold to hot across the junction—i.e., in the opposite direction to that obtained with the copper tubes, and of far greater magnitude. With a difference of temperature approximately estimated at 30 deg. C., the E.M.F. obtained was 74.6 microvolts.

A preliminary experiment has been made, in the case of iron, on the relation between the E.M.F. and the difference of temperature within the range of the above experiments. The method employed was as follows: When the whole had attained its temperature equi-

brum the steam was stopped while the current of cold water was continued as before; then, while the hot portion was cooling, readings of the two galvanometers were taken alternately, the one galvanometer in the thermo-electric iron-german silver circuit indicating the temperature difference, and the other in the main circuit indicating the E.M.F. From these alternate readings, taken at equal intervals of time, simultaneous readings were deduced by interpolation.

On plotting the curve (Fig. 3) giving the relation between the E.M.F. and the temperature difference it is found to be a straight line, showing that the E.M.F., in the case of iron and within the range of the experiments, is very nearly proportional to the difference of temperature, as indicated by the junctions placed in the manner described.

The following are the numbers from which Fig. 3 was drawn:

E.M.F.	Temperature Difference.	Ratio.
304.5	382	.797
287	352	.816
272	330	.824
256.5	310	.808
233.5	286	.816
213	267	.798
201	252	.798
188.5	236	.799
176.5	222	.795
165.5	207	.800
155	196	.791
145	182	.797
136	173	.786
128	162	.790
120.5	154	.783
114	144	.792
107.5	137	.785
101	129	.783
95.5	124	.772
90.5	117	.773
85.5	110	.777
81	104	.779
77	99	.778
73	94	.777
69.5	89	.781
66	84	.786
62.5	81	.790
60	77	.779
57.5	74	.777
54.5	71	.768

The results, so far, of these experiments are:

(1) The direction of the E.M.F. is opposite in the case of the two typical metals, iron and copper, being from hot to cold across the junction in the case of copper, and in the reverse direction in the case of iron.

(2) The magnitude of the E.M.F. is very much greater for iron than for copper, which corresponds to the much greater slope of the iron line in the thermo-electric diagram.

(3) The magnitude of the E.M.F. is, for the case of iron and within the range of the experiments, proportional to the abrupt difference of temperature on either side of the point of contact.

SERIES ELECTRICAL TRACTION (NORTHFLEET TRAMWAYS).*

BY EDWARD MANVILLE, M.I.E.E.

The expenses of horsing a tramway form such a serious proportion of the total working expense, that any cheaper effective method of propulsion will naturally be gladly received by the various companies.

Steam and compressed air have been extensively tried, and although in some cases their expense has compared favourably with horsing, the machinery used is so cumbersome, and the nuisance so great, that even companies who have incurred the expense of abandoning horses in favour of steam are seriously meditating the adoption of electricity.

The cable systems have met with considerable success in the United States, and have achieved some measure of success in the United Kingdom; but the conditions under which a cable line can be operated economically are tremendously heavy traffics, such as do not exist in the United Kingdom, but do in the United States, where, as is well known, tramcars are practically the only available street conveyances.

Many leading authorities in tramway administration who have tested and considered the various methods of tramcar propulsion, have of late publicly expressed their confidence in the great suitability and economy of electricity for the purpose. The subject is, therefore, one of peculiar significance, not only to shareholders in the direction of increased dividends, but also to the large body of the public using this popular method of conveyance from the point of view of reduced fares.

It is obvious that in systems of mechanical propulsion requiring the distribution of power over many miles of line, that the efficiency of the distribution will be better as the number of generating stations is diminished, and that the maximum economy is attained when all the power for a complete system is developed at one only.

To distribute electrical power economically from one generating station over distances such as are covered by tramway systems of any extent, it is essential that high-tension currents should be employed.

*Paper read before the British Association at Newcastle.

so as to minimise the loss of power in the conductors. Now, if the full tension of such currents were applied to the driving motor on each car, grave difficulties would present themselves in manipulation and in preserving the motor from injury. By the series system, however, it is possible by running the motors in series—as the name indicates—to attain the maximum ease of manipulation together with perfect safety to the motor. This was recognised at an early stage by the late Prof. Fleeming Jenkin and Profs. Ayrton and Perry, and the first electric locomotives ever run in series were used by them in connection with telferage.

The subject of electrical traction reached such a degree of prominence in this country that early last year steps were taken to demonstrate the practicability of running electric motors for tramcars in series with each other, and an electrical tramway on the series system was equipped and put into operation at Northfleet.

The essential parts of an electrical tramway line in which the motors are run in series are: an electric generator producing a current of constant quantity and an electrical pressure varying continually, according to the total work being done by the whole of the motors together; the conductor taking the current from the generator to the motors, provided with automatic switches of such a character as to enable the continuity of the conductor to be broken as long as the motor is in electrical contact with the open ends of the conductor, and to be closed as soon as the motor, in passing away, ceases to be in contact with the ends of the conductor.

This operation must be performed without disturbing the metallic continuity of the circuit, and without short-circuiting the motor.

The generator used at Northfleet is one of Statter's patent constant current dynamos, in which type of machine the E.M.F. is varied by the alteration of the position of the brushes on the commutator; this is effected by an electrical regulator. The current, after being generated in the dynamo, before going to line, passes through a solenoid containing a moving soft iron core. The position of this core regulates the position of the brushes by means of a double ratchet working on a wheel with two sets of teeth on its periphery, which wheel moves the brushes through a gear. The double ratchet is kept rapidly moving to and fro by an eccentric working off the dynamo shaft through a reducing gear. So long as the current is of the proper quantity, the position of the core is such that the ratchet does not engage with either of the two sets of teeth on the wheel, but when the current rises or falls the position of the core is altered, so as to cause the ratchet to engage with one or other of the sets of teeth, when the position of the brushes is rapidly altered to adjust the current quantity. The pole-pieces of the dynamo are so shaped as to reduce the "sparking" that might be supposed to result from the variation of the lead of the brushes so much as to make it practically negligible. The E.M.F. is varied from a few volts to upwards of 400. The current, after passing through the regulator, goes to a highly-insulated cable, reaching the whole length of the line. The cable is cut at distances of 21ft. along the line, and the ends of it are led into terminals connected with the opposite faces of a "spring-jack," which is at the same time the automatic switch and contact point from which the current is collected. From the last "spring-jack" at the end of the line, a return cable, with its insulation unbroken, is brought back to the other terminal of the generator, owing to the line at Northfleet being a single track.

The "spring-jack" just referred to consists of a pair of glazed earthenware blocks, 14in. by 3in. by 4in. To each block is attached, by means of a double spiral spring, a gunmetal casting, curved at the ends, but flat in the centre. The springs are of sufficient strength to press the two castings together with a force of 6lb.

Under the car, and for its entire length, is the collector, or "arrow," which consist of two thicknesses of indiarubber belting, each having a broad brass strip riveted to it for nearly its entire length. The nose of the "arrow" at each end is shod with wrought iron, brought to a knife edge, so as to easily force its way between the two faces of the "spring-jack," which automatically close after its passage. The maximum thickness of the "arrow" is 1in., which is consequently the extent to which the gunmetal cheeks are separated. The conductor on each side of the "arrow" is lapped round one end, and an insulated space is left, slightly greater than the surface of contact of the "spring-jack" near the extreme ends on opposite sides. By these gaps, the passage of the collector from one "spring-jack" to another is effected without short-circuiting the motor. The "arrow" is shown in the act of passing from one "spring-jack" to the other; one half of the "spring-jack" which is being entered, and one-half of that which is being left, together with the 21ft. length of cable between them is completely cut of circuit by means of these gaps, the continuity of the circuit being meanwhile maintained through the motor and the remaining opposite halves of the "spring-jacks." It will be readily seen from this that at no moment is the current cut off from the motor, or at no moment is the motor short-circuited. In fact the ammeter carried on each car shows the constant value of the current, without any variation.

The conductor on each side of the arrow is connected by an insulated cable with the motor carried on the car. On each platform of the car are two strong switches. One of these serves to reverse the direction of the rotation of the armature by altering the connections between the field-magnets and the armature, the other regulating the power of the motor by shunting more or less current from the field-magnets. Three speeds are provided for, and the stopping of the car is brought about by completely short-circuiting the field-magnet, still allowing the current to pass through the armature.

The motors are run at 400 revolutions per minute, delivering at this speed, when the field-magnets are fully excited, 15 h.p. on the brake. This slow speed was adopted to do away with intermediate gearing between the motor shaft and the car shaft, which has up to this time been the usual practice.

At Northfleet the motor pinion gears direct with a spur wheel on the car shaft in the ratio of 1—4½. The gearing is double helical,

with a view to noiseless running, and the practical working of this gear is most satisfactory.

The motors are mounted in a way now generally adopted in the United States, one end being supported by two half bearings on the driving shaft of the car, the other end being suspended by a spiral spring from a stout beam across the car body.

The motors are of the Elwell-Parker type, and the field-magnets are connected in series to the armature. One of the cars is lighted electrically by means of low-resistance Bernstein lamps. Three accumulator cells, of the tramway type of the Electrical Power Storage Company, are inserted in the main circuit, and five lamps of 10 amperes each and 6·5 volts are run in parallel off the accumulators. The accumulators themselves, however, are not discharged; they only serve as potential reducers, the whole of the main current going through the lamps. Should one of the lamps break, the remainder are slightly more brightly incandesced, and the current due to the broken lamp passes through the accumulator. A two-way switch enables the accumulator to be taken in or out of the main circuit, and the accumulators are large enough to run all the lamps without assistance from the main current, should it be requisite.

The generator is driven by a Roby compound under-type engine of 10 h.p. (nominal), with a locomotive boiler over it.

The appearance of the tramway on the road surface is in all respects similar to that of an ordinary tramway, the conduit through which the "arrow" travels, and in which the "spring-jacks" or contact points are situated, being formed beneath one of the running rails. This running rail differs from the ordinary tramway rail, inasmuch as the tread and guard portions consist of two separate and independent rails, having a narrow slot ½in. in width between them, through which the mechanical connections between the "arrow" travelling in the slot and the car body are situated. By this means any further interference with the surface of the road than that which is common to all tramway systems is avoided. The tube is 8in. in width, the bottom being 13in. below the surface of the road, this being an exceptionally small conduit as compared with the conduits commonly in use for cable tramways, such conduits having the further disadvantage of necessitating two central rails, owing to their being situated in the middle of the track. The rails are supported by means of cast-iron chairs or yokes, to which they are securely bolted. These yokes are placed at intervals of about 4ft., excepting at the rail-joints, where they are closer together, the sides and bottom of the tube between these yokes being formed of Portland cement concrete. The rails are made in 21ft. lengths, corresponding with the distance apart of the "spring-jacks," and at each rail-joint a special chamber is formed, having a convenient removable lid, by means of which access is obtained to the "spring-jacks." The yokes on either side of the joints are similar to the ordinary yokes, excepting that they are provided with recesses to receive the stoneware separating blocks, to which the "spring-jack" cheeks are attached. The rail-joints themselves are fished in the ordinary manner. The centre of the tube is placed somewhat inside the track, in order that the "arrow," when travelling, shall not be directly underneath the slot, so as to avoid the danger of water from the road surface in wet weather falling directly on the "arrow," and also with a view to protecting the "spring-jack" cheeks themselves in a similar manner. The roof of the conduit between the yokes is formed by a Z-shaped roof plate. The cable joining the "spring-jacks" is led in an independent 3in. earthenware pipe, running from chamber to chamber, and in this tube also is laid the return cable. Some special construction of points and crossings is necessitated, owing to the junction or crossing of the two tubes underneath the track, which involves a considerable projection of unsupported tongue. In order to secure the safety of ordinary traffic passing over these tongues, a tumbler or rocking device has been provided, which forms a support for the toe of the tongue when the car is not over the point, but which, during the passage of the car, is pressed aside by means of the "arrow" shanks, which will be referred to hereafter.

Owing to the narrowness of a portion of the road, the Board of Trade required that the line in this part should be constructed in a manner technically known as a "double-single" line; that is to say, with three rails, so as, while keeping the tramway cars on the proper side of the road in the direction they are travelling, and thus allowing clearance for ordinary road traffic, to prohibit the possibility of two tramway cars passing each other in this narrow part. At this portion of the line two of the rails had to be formed with conduits, the third being an ordinary tramway rail. Some special forms of construction, as regards points and crossings, were necessitated in this portion of the road, but space does not permit of a full description being given of these and many other mechanical contrivances which had to be provided. They, however, are arranged so as under all circumstances to automatically guide the car with its "arrow" in the right direction. Drainpipes are provided for the removal of water from the tube.

The "arrow" or collector referred to before is supported by means of five shanks, these shanks being attached to cast-iron "shoes" or "skates," which travel on the rail, these being drawn by means of chains attached to the car body, and connected by light tie-bars above the rail level. The leading shank in either direction is provided with a plough or stone-thrower, for the purpose of removing any obstruction which may be met with in the slot. The insulated cables connecting the conductors on the "arrow" with the motor are led up through recesses in two of the shanks and skates. The mechanical details of the system were designed by Mr. Joseph Kincaid, and carried out for him under the supervision of Mr. J. S. Waller.

It may be well to point out, in series running, that owing to the employment of a current of constant value, it is impossible for the most inexperienced car driver to damage his motor by either too rapid starting or by reversing whilst running; indeed, it is a positive advantage when descending a hill to check the speed of the

car by altering the field connections so that the armature tends to revolve in the opposite direction to that in which the car is travelling, as the power that would otherwise be lost in breaking the car is actually added to that produced by the generator, and thus large systems with many cars and varying gradients would appreciably reduce the total power required to be generated, and the consequent consumption of coal.

These advantages, combined with the efficiency of distribution as regards the percentage of power lost in the conductors, with, at the same time, but a low difference of potential at the terminals of each individual motor, may be regarded as the main advantages of series running.

[This system was fully illustrated in our issue of March 15th, to which issue our readers can refer for illustrations.—ED. E. E.]

NEW COMPANIES REGISTERED.

Electric Wiring and Fittings Company, Limited.—Registered by Davidson and Morris, 40 and 42, Queen Victoria-street, E.C., with a capital of £5,000, in £1 shares. Object: to carry on the business of manufacturers of, and to buy, sell, hire, let, and deal in dynamos, mains, batteries, lamps, etc., and generally as electricians and mechanical engineers. There shall not be less than three nor more than five Directors. Qualification, being a shareholder. Remuneration to be determined in general meeting.

Williamson Electrical and Engineering Company, Limited. Registered by Needham, Parkinson, and Slack, 10, York-street, Manchester, with a capital of £5,000 in £10 shares. Object: to commence, carry on, continue and develop, either in New South Wales or elsewhere the business of electrical and general engineers. The regulations of Table A, with slight modifications, apply.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for the week ended September 6 amounted to £3,048.

Commercial Cable Company.—According to a Reuter's telegram from New York, the Commercial Cable Company has declared a dividend of 1½ per cent. for the current quarter.

West India and Panama Telegraph Company.—The traffic receipts for the half-month ending September 15 show a decrease of £456 as compared with the corresponding period.

Western and Brazilian Telegraph Company, Limited.—The receipts for the week ended September 6, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £1,911.

Edmundson's, Limited.—The first annual meeting of Edmundson's, Limited, was held on the 15th inst., at 19, Great George-street, Westminster, Mr. John R. Wigham, J.P., in the chair. The accounts showed a profit on the year's working of 11 per cent., and the directors recommended a dividend of 8 per cent. and a carry over of £1,655. The Chairman congratulated the proprietors on the success of their first year's trading, and that the forecasts in the Company's prospectus had been much more than realised. The business of the Company had been 50 per cent. greater than in the previous year, and there was evidence of a continuance of this prosperity in the current year.

PROVISIONAL PATENTS, 1889.

SEPTEMBER 9.

14163. **Improvements in or connected with telephones.** Richard Steenberg, 2, St. Nicholas-buildings, Newcastle-on-Tyne.
14189. **Improvements in arrangements and mechanism for storing power, and applying the same to start or assist in starting electric, gas, and other engines, tram-cars, omnibuses, and other vehicles.** William Gifford, 23, New Bailey-street, Salford.
14206. **An improvement in battery jars for electrical and other similar apparatus.** James Bridger, 33, Southampton-buildings, London.
14215. **Improvements in and relating to the transmission of electric impulses for the purposes of telegraphy and telephony.** George Forbes, 24, Southampton-buildings, London.
14218. **An improved system of and apparatus for telegraphy.** John Corry Fell, 1, Queen Victoria-street, London. (Samuel Vyle, British Guiana.)

SEPTEMBER 10.

14232. **Improvements in magneto-electric machines.** Herbert John Allison, 52, Chancery-lane, London. (Arden Seymour Fitch, United States.) (Complete specification.)
14249. **An improvement in ceiling fixings for electric lights and switches.** John Owen Girdlestone and Sydney Bousfield Tatham, 31, King-street, Covent-garden.
14262. **Improvements in electric switches and cut-out, wall sockets, ceiling bases, and the like.** George Wilkinson, 2, Princes-mansions, Victoria-street, London.

14279. **A new or improved magnetic separator.** Herbert John Haddan, 18, Buckingham-street, Strand, London. (Gordon Conkling, United States.) (Complete specification.)

14280. **A new or improved process for separating magnetic from non-magnetic particles.** Herbert John Haddan, 18, Buckingham-street, Strand, London. (Gordon Conkling, United States.) (Complete specification.)

SEPTEMBER 11.

14321. **Improvements in and relating to the brush-holders of dynamo-electric machines.** George Edensor Dorman, The Hawthorns, Stafford.

14333. **An improved incandescence lamp mounting with current interruptor.** Friedrich Wilhelm Arnold, 142, Fleet-street, London. (Complete specification.)

14342. **Improvements in or relating to accumulators or secondary batteries for use in lighting railway carriages and other conveyances by electricity.** John Clayton Mewburn, 55 and 56, Chancery-lane, London. (La Société Anonyme pour le Travail Electrique des Métaux, France.)

SEPTEMBER 12.

14366. **Improvements in or relating to arc lamps.** Wilfrid Swanwick Boulton, 24, King's Mount, Birkenhead.

14374. **Improvements in electric arc lamps.** George Edensor Dorman, The Hawthorns, Stafford.

14377. **Process of and apparatus for maintaining uniform current in electric lighting circuits.** Julien May Bradford, 6, Monroe-place, Portland, Maine, U.S.

14390. **Improvements in apparatus for transmitting electric currents to and from the commutators of dynamo-electric machines.** George Edensor Dorman, The Hawthorns, Stafford.

SEPTEMBER 13.

14447. **Improvements in or appertaining to electric or cable propelled rail or tramway cars, and to brake mechanism therefor, partly applicable to other vehicles.** William Phillips Thompson, 6, Lord-street, Liverpool. (Sumner Alexander Bemis and Louis Pfingst, United States.)

14448. **An electric chair for nervous and other diseases.** Edward Moross, 37A, Outer Temple, Strand, Middlesex.

14453. **Improved means for regulating the working of dynamo-electric machines.** Henry Harper and Reginald Page Wilson, 191, Fleet-street, London.

14464. **Improvements in electricity meters.** Emile Batault, 68, Fleet-street, London. (Date applied for under Patents Act, 1883, section 103, 15th February, 1889, being date of application in Switzerland.)

SEPTEMBER 14.

14485. **Improvements in magneto electric bells or generators.** Arthur Greenwood, Woodhall Hills, Calverley, near Leeds.

14504. **An improved instrument for regulating electromotive force.** William Henry Douglas and Thomas Hugh Parker, 77, Colmore-row, Birmingham. (Complete specification.)

SPECIFICATIONS PUBLISHED

1888.

11897. **Indicating strength of electric current.** Shallenberger. 8d.

14703. **Regulating electric currents.** Willans. 8d.

15216. **Electric switches.** Dorman and Smith. 8d.

15324. **Train electrical communication.** Margetson. 8d.

16140. **Charging secondary batteries.** Tyer. 8d.

18526. **Submarine telegraph cables.** Loeffler. 6d.

1889.

11071. **Connecting carbon filaments to metallic conductors, &c.** Lake (Lemp). 8d.

11732. **Electric telegraphs.** Anderson. 1s. 1d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.	Name	Paid.	Price Wedne day
12 Feb. 1/2	Anglo-American Brush E.L.	—	—
12 Feb. 2/0	— fully paid ..	—	—
14 Nov. 0/4½	Con Telephone & Main ...	1	3
27 July 10/0	India Rubber, G. P. & Tel.	10	19½
.....	House-to-House	4½	4½
.....	Metroptn Electric Supply	—	2½
.....	London Electric Supply ...	5	3½
.....	Swan United	3½	4½
12 July 12/0	Telegraph Construction ...	12	43½
2 July 6/0	— 6%, 1889	100	105
... ..	National Telephone	5	6½

NOTES.

Personal.—Mr. and Mrs. Brooks sailed for America from Southampton on the steamer "Columbia," last Friday.

Telephone Patents.—An injunction has been made restraining Messrs. Norton and Co. from infringing the United Telephone Company's patents.

City Lighting.—The question of the lighting of the City was brought up at the meeting of the Commissioners of Sewers on Tuesday, and again adjourned.

Personal.—Mr. E. L. Joseph has resigned his position with Mr. Julius Sax, and has joined the firm of Messrs. Appleton, Burbey, and Williamson as traveller.

Vienna.—The Amalgamated International Company of Vienna, working with Ganz and Co., are laying themselves out for the supply of 100,000 lamps for that city.

Edison Works.—The Edison works at Schenectady are to be greatly enlarged, and three more large buildings are to be added. The shops now employ 1,300 men.

Dutch Cables.—The Dutch Budget, just published, contains measures proposed for the construction of a telegraph cable between Macassar in Celebes, and Bandjermassar in Borneo.

Railway Congress.—The question of the electric light on railways was discussed at the Paris Railway Congress with some attention. The next congress will be held in St. Petersburg.

Strike at Silvertown.—The strike at the East-end of London extended to the works of the India Rubber and Gutta Percha and Telegraph Company, Silvertown, and 1,400 men turned out on the 19th inst.

Sunbeam Lamps.—The Sunbeam Lamp Company, Gateshead, have issued their revised price list of sunbeam lamps. Owing to improved facilities in the manufacture of these lamps, they are able to make a considerable reduction in the prices, as compared with the previous list.

A Powerful Incandescent Lamp.—Messrs. J. H. Holmes and Co., of Newcastle, have manufactured for the Sunbeam Lamp Company an incandescent lamp of 3,000 c.p. for temporary use at the Newcastle Museum. This is believed to be the most powerful incandescent lamp yet produced.

Institute of Medical Electricity.—A course of 10 lectures and demonstrations on electro-physiology and therapeutics will be given at the above institute, 24a, Regent-street, near Jermyn-street, on Tuesdays at 8 p.m., commencing October 8, by Arthur Harries, M.D., and H. Newman Lawrence.

Rating of Machinery.—A meeting of manufacturers, held at Bristol, resolved to form a National Society for the Exemption of Machinery from Rating. Mr. Humphreys Davies, F.S.I., rating surveyor of the Adelphi, London, was appointed secretary, and arrangements have been made for extensive organisation.

Leeds Musical Festival.—The arrangements for lighting the Leeds Town Hall, inside and out, by electricity during the forthcoming musical festival, undertaken by the Electric Lighting Committee, have been completed, and are of a character which give complete satisfaction to the executive committee of the festival.

Lyons Tramways.—The tramway company of Lyons are reported as being on the point of changing from horses to compressed air. After the many demonstrations of the superiority of electricity for traction it is surprising to hear the compressed air is still preferred in France. Possibly the directors are fond of change and do not mind another.

Aberdeen.—The Gas Committee of Aberdeen Town Council had the subject of electric lighting again under consideration on Tuesday, when it was agreed to recommend the Council to apply for a provisional order to prevent private companies from being permitted to light the city with electricity, the Council to reserve this power to themselves.

Leeds.—At a meeting of the Electric Lighting Committee of the Leeds Corporation on Monday, it was stated that information had been obtained as to supplying the electric light to a certain portion of the borough, but the question as to whether the lighting should be conducted by the Corporation or by a private company was left to the decision of the Town Council, the information obtained to be supplied to every member of that body.

St. Martin's.—At the last meeting of the St. Martin-in-the-Fields Vestry a letter was read from Messrs. Bircham, on behalf of the Metropolitan Electric Supply Company, stating that they cannot deposit the sum of £1,000 required by section 6 of their Bill until after the Royal assent has been given to it, and they were prepared to give security for the estimated cost of making good the roadways over the mains. On consideration of this, and having regard to the work already performed by the company, the Vestry came to the conclusion that the deposit of £1,000 was not necessary.

Wrexham.—The electric light is being rapidly introduced into the collieries, works, hotels, and breweries in the Wrexham district. The Llay Hall Colliery, Wrexham, was lighted for the first time last week, the installation comprising 100 lamps of 16 and 32 c.p., fitted up in the engine-room, stables, and offices. The work was carried out by Messrs. W. Sillery and Co., Wrexham, who use a dynamo made by themselves. The same firm have supplied 32 lamps at Felinpuleston Flour Mills, Wrexham. Here the installation comprises a set of 14 Elwell-Parker storage batteries, charged by a Crompton dynamo. The results in both cases are highly satisfactory.

Portable Extending Platform.—The British Museum authorities have just purchased a new pattern portable extension combined step-ladder and platform, upon which two men can stand, and while it can be raised to 18ft. it telescopes down to 11ft., and can be wheeled about and turned by one man. Messrs. J. H. Heathman, of 11, High-street, Bloomsbury, have, in addition to the above, also supplied an extension ladder 20ft. long, which extends up to 36ft. 6in., to be raised and extended by one man. These are made so that they can stop at intermediate heights, and are used in connection with the electric light installation for cleaning or attending to the lamps.

The Westinghouse Campaign.—English electrical manufacturers have been striving with their might to get all the work they could do, and now we suppose they will have to strive a little harder still. The Westinghouse Company have decided to open a branch works in England, to be situated in York-road adjoining the Westinghouse Air Brake Works, London. Mr. H. M. Byllesby, general

manager of the Westinghouse Electrical Company, has come over with a corps of electrical experts, and will superintend the construction and equipment of the works, and to make arrangements for the introduction of Westinghouse apparatus. The company has been registered in England, and has not actual connection with the American company.

Manufacture of Gas by Electricity.—According to the *New York Electrical Review*, a syndicate of moneyed parties in Massachusetts are reported to be perfecting a process for making the common illuminating gas by electricity. If it meets the claims set up for it, natural gas will have a formidable rival. Common petroleum is vaporised by means of heat caused by an electrical current through some metal. Two very material advantages are claimed for it. The leading one is its cheapness. The cost of manufacture is put as low as 17 cents per 1,000ft. The other is the simplicity of the machine, which is said to not occupy more space than an office desk. This will furnish light, heat, and power for a large manufactory at half the ordinary cost.

Tenders for Barnsley.—The rise attempted by the Barnsley Gas Company from 3s. to 3s. 4d. per 1,000, has resulted, as we expected, in some bitter comments and some practical action in the direction of electric light. A petition is being formed to ask the mayor to call a meeting. Bradford's example will be fresh in their minds, and a little energetic action on the part of electrical engineers would come in at a spring tide of opinion. As to the practical action already taken, the Barnsley Co-operative Society have been led to consider the question of their own lighting. They find that they paid last year for gas about £562, and the increase in price would mean an additional £60 or £70 a year for lighting their central stores. Having had experience of the electric light at their mill and warehouses, it was resolved on Tuesday night that estimates for plant for lighting the whole of the central stores be at once sought.

Lacombe Carbons.—The large arc carbons for the St. Catherine's Lighthouse, Isle of Wight, are supplied to the Trinity House authorities by Messrs. Lacombe and Co., of Levallois-Perret, near Paris. These carbons are of a high quality, and are 2½ in. across. They are of the fluted pattern, designed by Sir James Douglas himself, and are remarkably efficacious in keeping the arc steady and central. The five projecting flutings act, as it were, like five fingers to fix the arc in its place, the flutings supplying the carbon for consumption, and the centre acting as the main conductor. The current is a very heavy one, 300 to 400 amperes alternating current, and the light given in the beam is equal to 6,500,000 candles. These fluted carbons are now being considerably employed by the makers and users of search lights, who find their advantage in steadiness. The ordinary Lacombe arc carbons are also much used, among others the lamps at the Paddington installation being supplied with these carbons.

Holborn.—At the Holborn Board of Works on Monday a letter was read from the solicitors to the Metropolitan Electric Supply Company giving some particulars as to the stability of the company, stating that the nominal capital of the company was £500,000, divided into 50,000 shares of £10 each. Amount subscribed, £460,320; amount to credit of the company, £148,600; calls in arrear, £4,415. Mr. Wood suggested that the electric light company in laying down their wires should be only allowed to open one portion of the roadway at the time.

The Surveyor said that he had somewhat anticipated Mr. Wood, for that morning he had addressed a letter to the engineer of the Metropolitan Electric Supply Company asking him to call at the Town Hall, so that they may settle the mode and manner in which the work is to be executed. He might say that one of the objects he had in view was to reduce as much as possible the inconvenience that would be caused to the public by the work.

Electro Harmonic Society.—The first smoking concert of the season will take place this evening (Friday) at the St. James's Restaurant, Banqueting Room, at eight o'clock. The artistes will be: Mr. William Nicholl, Mr. James Kift, Mr. Arthur Thompson, and Mr. Frederick Bevan; solo clarinet, Mr. Leonard Beddome; solo pianist and accompanist, Mr. Alfred Izard; musical directors, Mr. T. G. Gatehouse and Mr. Arthur Thompson. The following is the programme: Part 1.—Part song, "Spring's Delights" (Müller); song (MS.), "Kitty Bawn" (Mary Carmichael), Mr. Wm. Nicholl; clarinet solo, "Andante" (Kücken), Mr. Leonard Beddome; song, "The Valley" (Gounod), Mr. Frederick Bevan; songs, (a) "Absence," (b) "Better Far" (Cowen), Mr. Arthur Thompson; humorous song, Mr. James Kift. Part 2.—Quartet, "Breathe, my Harp" (Bishop); solo pianoforte, (a) Nocturne in D flat, (b) Valse in A flat (Chopin), Mr. Alfred Izard; song, "Forget Me Not" (Eaton Faning), Mr. Wm. Nicholl; duet (piano and clarinet), Fantasia on "Der Freischütz" (Eschmann), Mr. Alfred Izard and Mr. Leonard Beddome; song, "The Devout Lover" (M. V. White), Mr. Frederick Bevan; humorous song, Mr. James Kift; part song, "Come, boys, drink, and merry be" (Marschner).

Celluvert Insulation.—We have had some samples of the new paper insulation sent to us by Messrs. David Moseley and Sons, Ardwick, Manchester. The name given to this new substance is "Celluvert," and, as its name implies, it is made of converted cellulose of cotton or other vegetable fibre, chemically treated. It is a horn-like substance, hard, shiny and smooth, and is made in different colours—dark red, black or stone colour. Some of the samples are of the thickness of paper, one-hundredth of an inch thick, and quite flexible. Other samples are rolled tubes about ¾ in. diameter, perfectly smooth inside. Its insulating powers are high, and it will withstand a large degree of heat. Messrs. Verity and Sons, who have been one of the first to use the material for their switches, have found it very satisfactory. As a substance it stands, as it were, between metal and wood; it has no stratification, and can be filed, turned, sawed, and tapped, though it cannot be moulded. It takes a high polish, varnishes well, and can be glued to itself or to wood. It resists oils, and acids affect it but slightly; and it has a wonderful tensile and crushing strain as tested at the United States testing machine. A short contact with water does not affect it, but several hours soaking expands it somewhat, and it resumes its original shape on drying. It is made in sizes up to slabs of 1½ in. thick, and in various sizes of tubes. Celluvert should prove exceedingly useful in the manufacture of electrical plant and apparatus.

Utilising the Rhine.—The company formed at Basle for the utilisation of the water power of the Rhine is an experiment company, to acquire and complete the present work done, and obtain the Government concession, and will afterwards raise the necessary capital by the formation of a full company. The company is composed of the following persons and companies: Allgemeine Electricitäts Gesellschaft,

Berlin; Escher, Wyss and Cie., Zurich; Oerlikon Works, Oerlikon; Zscholke and Co., Aarau; Berliner Handelsgesellschaft, Berlin; Director W. Bröderlin, Arlesheim; E. Burgin, engineer, Basle; Deutsche Bank, Berlin; R. Geigy-Meriam, Basle; Kienheim and Co., Berlin; and Sulzbach Brothers, Frankfort-on-Maine. The committee is composed of the following gentlemen: Colonel Huber, Zurich; Mr. Naville, engineer, Zurich; Director Rathenau, Berlin. The committee will now work out in detail the projects and calculations for the establishment in Rheinfelden, and that for the electrical transmission of the power obtained at Basle, the Wiesenthal, Säckingen and the Basle country. Canvass will also be made both of corporations, manufacturers, and private persons in the surrounding districts with reference to supply of transmitted power either for light or for power. It is hoped to obtain the concessions, so that if, possible, building operations may be commenced early next year and finished by 1891, when, if this programme is carried out, we shall have the distribution of the power from water to various towns from the centre amply demonstrated.

Lightning Conductors in Chelsea.—The Chelsea Vestry on Monday adopted the following recommendations of the acting-surveyor (Mr. T. W. E. Higgins) with regard to lightning-conductors under public highways: 1. The lightning-conductors shall be of iron or copper. 2. It shall be properly and efficiently connected to earth. 3. The upper terminal of the conductor shall where possible be properly connected to a metallic water-main, but on no account shall it be in contact with small lead pipes. 4. Whether connected to metallic mains or not, the lower terminal shall be connected to a mass of metal having a total surface of at least four square feet buried to a depth of at least four feet, and which shall be in actual contact with moist earth. 5. If necessary, such mass of metal shall be surrounded with coke or charcoal and soda. 6. The conductor must possess a mechanical strength, and offer a resistance to electrical discharges equal to that of a strand of seven No. 16 galvanised iron wires. 7. The earth connection plate shall not be fixed until the surveyor to the Vestry is satisfied that the ground in which it is to be fixed is suitable for the purpose. 8. Before the conductor is fixed, the owner of the building which is to be protected by it is to give an undertaking in writing that he will be responsible to the Vestry for all damage caused to public property by the action of lightning on such conductor and its connections, and will make good any damage to the satisfaction of the Vestry. 9. Whenever required by the Vestry or their surveyor, the owner of such conductor shall submit to the Vestry a certificate in writing from some competent person to say that such conductor has been tested and found in a satisfactory condition. 10. The conductor and its earth connections shall be removed at any time, upon notice in writing being given to the owners by the Vestry.

Primary Batteries.—Mr. W. L. Silvey, of Lima, Ohio, is a great believer in a primary battery which he has been working upon. Of course there is a solution, of which the nature is not disclosed, but he seems to have been able to obtain a strong and steady current. According to the account given, he says: "I have made hundreds of chemical experiments with a view of simplifying my battery, and have reduced the number of ingredients from nine to five, and the first cost in manufacture fully 25 per cent. I will give you an idea of what I have actually done with this battery. I took a cell in which the zinc plate

was 10in. long, 7in. deep, carbons of the same size, $\frac{1}{2}$ in. thick, and with one charge of the battery I drew out 45 amperes for 14 successive hours without rest. The voltage at the start was 1.94 volts, and at the end of the run was 1.90 volts. Without recharging this cell, I discharged it at the rate of 15 amperes per hour for 40 hours, during which time there was a drop of only 0.2 volt. During this run 18 ounces of zinc were consumed. In this battery we use two solutions and a porous cup. The solution in the porous cup is the new discovery, but as we are not fully protected by United States patents, we withhold a description for a future time. In the outer cell containing the zinc is water, slightly acidulated with sulphuric acid, one part of acid to twenty parts of water by weight. The zinc rests in a cup, in which a small quantity of mercury is placed. This keeps it thoroughly amalgamated, and prevents all local action. To renew this outer solution, part of the water is drawn off and replaced by fresh water without any acid. I have found experimentally that the sulphate of zinc does not do any harm until the solution becomes saturated, at which time a very wasteful local action takes place. The solution in the porous cell, when fresh, is almost as thick as molasses and of an amber hue. The internal resistance of the cell is practically nothing."

Reporting Progress.—October 1 is the date fixed for the first lighting up of Deptford station, and great efforts are being made to carry out this intention. A start of the first engine was made last Sunday, and the first 10,000-volt dynamo the world has seen has been running so far satisfactorily. The current was not put on the lamps, but was run through a resistance, the trouble of stringing up a hundred 100-volt lamps being considerable, and as an electrical test the resistance is equally good. But the trial intended was more as a mechanical test of the running powers of the engine and dynamo. Some idea of the size of the "small" dynamo may be obtained from the mention of the fact that two flights of iron steps have to be ascended to reach the steam-valves, and the driving gear of 40 cotton ropes. So far everything seems satisfactory. The cable is laid all the way from Deptford to Charing Cross, with the exception of a small section of underground across the railway lines at Charing Cross, which had not been connected last Sunday as intended. The London Electric Company's first 10,000-volt transformer station will be at the Adelphi arches, where they have taken some extensive and convenient premises just below the offices of the company at Adelphi-terrace. Here considerable activity is apparent, and some of the 100 h.p. transformers are in their places—an imposing array of dangerous individuals. These have all been tested up to 13,000 volts with a current transformed up with ordinary transformers, and to 50,000 with an induction spark. The company have had some difficulty with their first intended supply station, which is situated in Maiden-lane, behind the Adelphi Theatre, Charing Cross. Here they had taken a whole house and shop, concrete floored, and had put in an hydraulic lift to manipulate the heavy transformers. But it appears that owing to the readjustments of the Board of Trade enquiry, the district is now practically outside their jurisdiction. The station, however, is being connected up, and the underground cables are laid connecting to Adelphi arches, but the place will be used, not as a distributing station so much as the point of connection with the overhead system of the Grosvenor installation. The current will be brought

to Maiden-lane, not on the 10,000 circuit as first intended, but on the 2,400-volt circuit. The cable for these is being taken up overhead and connected to the Grosvenor mains. It will be seen, therefore, that Mr. Ferranti has abandoned his intention at first held of sending the 10,000-volt current overhead to the Grosvenor. Ultimately this will be done underground, no doubt, and the Grosvenor made a distributing centre, but all the mains, primary and secondary, have first to be laid underground.

Finsbury College.—The session of the Finsbury Technical College will reopen on Monday next, Sept. 30th. The evening classes at the college are now attended by about 1,000 students, and of these about 300 are apprentices admitted at half fees. There will be two courses on electrical technology, by Professor Silvanus Thompson and his assistants. Course AA, every Wednesday, at 8 p.m., is the more elementary, by Prof. Thompson and Mr. E. A. O'Keeffe, will consist of illustrations of the practical uses of electricity, magnetism, magnetometers, electromagnets, electric bells, electric generators, ampere-meters, calibration, voltmeters, batteries, thermo-batteries, coulomb-meters, electrometers, condensers, insulation, resistances, fault testing, testing instruments, electrifying machines, influence machines, lightning-conductors, ergmeters, and wattmeters. A practical laboratory class is held for two hours before the lecture with the object of giving students a practical acquaintance with the measurement of currents and calibration of instruments; and the use of the ordinary test instruments, Wheatstone bridge, reflecting galvanometer, etc., with practical use of notebooks, and curves on squared paper. Course BB, by Prof. Thompson and Mr. W. Robinson, will consist of a lecture on Mondays at 8 p.m. These will be more advanced, and will deal with dynamo-electric machines, electromotors, alternate-current dynamos, measuring instruments for alternate currents, induction-coils, transformers, arc lamps, glow lamps, conditions of electric distribution, accumulators, coal consumption to produce electric energy, conductors, cost of producing light electrically, cost of transmitting power electrically, electric railways. A laboratory course will also precede these lectures, and instruction will be given in practical management of dynamo-electrical machines, arc lamps, glow lamps, calibration of electrical measuring instruments, and in the higher branches of electric testing, including use of quadrant-electrometer and the testing of submarine cables. A special course of ten lectures on the design of dynamo machinery will be given by Prof. Thompson on Monday evenings, at 8 p.m., from September 30 to Christmas. These lectures will deal with the design and construction of dynamo machines and motors of various types, with special reference to alternate-current working. The fee for this course is six shillings. A special course of laboratory instruction in electro-plating will also be given by Mr. Rousseau on Tuesday evenings, from 6 to 8.30 p.m.; together with occasional lectures by Prof. Thompson on Thursday evenings, the dates of which will be announced. The course is devoted to the modern practical processes of nickel-plating, steel-plating, coppering, electro-brassing, electro-plating with silver, electro-gilding, etc. Special attention will be paid to the use, in plating, of the dynamo-electric machine, and of the proper modern practical instruments for measuring the current supplied to the baths. Students will be instructed in proper methods of preparing articles for the bath, and of managing the current to secure thoroughly good deposits. They are also taught how to prepare and test the solutions themselves, and to make moulds in plaster, gutta-percha,

etc. The fees for the various classes vary from 6s. to 30s. for a period of eight months.

Decision at Paddington.—A meeting of the Paddington Vestry was held at the Vestry Hall, Harrow-road, on Tuesday morning, under the presidency of Mr. Jackson, to consider what action should be taken with respect to the introduction of the electric light into the parish. A committee which has been considering the subject reported that in their opinion it would be advisable for the Vestry to entrust the work of electric lighting to a well-established company, and in view of the possibility of the local authority desiring to purchase at any future time the undertaking of any company in the parish, the committee considered that it should be a *sine qua non* that the central stations for the production and supply of electricity should be constructed and the distributing mains laid so as to form a complete installation for Paddington, independent of all connection with other parishes. Mr. Minchin proposed, "That, in the interests of the ratepayers, the Vestry do keep the supply of electric lighting for Paddington in its own hands, and in order that such work may be carried out a capital of not exceeding £50,000 be raised on the security of the lighting rate." He pointed out that for the sum indicated the Vestry could provide 100 arc lights and 10,000 incandescents, and such important thoroughfares as Bayswater-grove and Harrow-road should be lighted by electricity. The incandescents should be supplied to private consumers, and the cost would be £17,000 a year, but the revenue derived from the sale of the light would be £29,000 a year. A halfpenny rate would be sufficient for the raising of the money required. Mr. W. Owen seconded. Mr. Mark Judge (chairman of the Electric Lighting Committee) proposed as an amendment, "That, inasmuch as the Electric Lighting Committee has not seen its way to recommend the Vestry itself to undertake to provide electricity, it is desirable that steps be taken to secure its being done at an early date by private enterprise, under a provisional order approved by the Vestry, and that such order should embody a clause to the effect that the Vestry should be entitled at the end of 21 or 31 years to purchase the undertaking." Mr. Mills seconded the amendment, and Mr. R. F. Whur, who supported, observed that a great many of the ratepayers were against the Vestry's undertaking the supply. Mr. W. Clark said the ratepayers strongly objected to the Vestry speculating with their money. It would be a gigantic undertaking, and it would cost an immense amount of money. Colonel Blair, R.E., said he was strongly opposed to the Vestry's undertaking the supply. It was not their duty to do this work, and he could not trust this Vestry with the management of such an undertaking. Mr. See was in favour of the Vestry's undertaking to supply the electric light. The first part of Mr. Judge's amendment, that the supply should be undertaken by a private company, was eventually carried by a majority of 26 to 4, but the stipulation as to time was left over for discussion at the next meeting, which was settled for next Thursday week, at 10 a.m. A number of items in the second proposed motion as to the desirability of two competing systems, charges, overhead wires, and the free use of conduits to the Vestry for other wires, were also left over for next meeting.

The Dangers of Electricity.—Mr. W. H. Preece replies as follows in Tuesday's *Times* to the criticisms on remarks at the British Association published last week: "Sir, I have

read a great many wonderful criticisms of what I am supposed to have said at Newcastle on the dangers of electric currents, but I have not yet read one on what I really did say. I certainly did not say that alternate currents of high pressure were not dangerous to life, nor that wires conveying such currents may be handled with perfect safety, nor that deaths due to shocks received from electric light wires have been found on investigation to be nonsense: what I did characterise as absolute nonsense was the reason a mining engineer adduced against using electric currents for the transmission of power in mines—viz., that a man who touched such a wire would be killed. Such currents are invariably direct currents of low pressure, and are, therefore, quite safe. I also questioned the propriety of employing electricity for executing criminals, and I intended, as the writer of your admirable summary of the work of the British Association said, to throw 'grave doubts on the invariable certainty of death even from a powerful discharge of electricity.' In fact, no one can yet determine the current which will infallibly kill a man without torture. I also referred to the propensity of newspaper correspondents to rush into conclusions at once that electric light currents were the sole cause of death, by adducing, amongst others, the Brighton case, where grave doubts as to the cause of death exist—doubts that are amply confirmed by Dr. Whittington-Lowe's letter, published by you on the 19th inst. It was a mistake to couple Major Cardew's name with the conclusion arrived at as to the stoppage of the current. The information on which I spoke was given to me by the local manager of the Electric Light Company. I have already received a shock of 2,000 volts, and one of even greater voltage, for once I accidentally discharged a Leyden jar through my body, and I have not the slightest desire to repeat the experiment. I am far from under-rating the dangers of electric currents, and it is surprising that some of my critics should think otherwise, when they know the active part I have taken in preparing rules and regulations for protection from fire and to person. In fact, I have acted as chairman of three committees dealing with those questions. The principal object of my remarks upon alternate currents was to emphasise the advisability of employing safety devices, such as the one described by Mr. Killingworth Hedges, which was the object under discussion. The result of experience is conclusive that electricity with proper precautions can be made safe, both from fire and death. Every accident due to electric light wires, unfortunately too numerous, with which I am acquainted, has been traced to stupidity, ignorance, or carelessness, sources of danger much more prevalent with gas and steam than with electricity, and everyone remediable and provided against in regulations extant, but neglected. It cannot be too strongly urged that the great sources of danger in electric light wires are bad material, inexperienced workmen, neglect of rules, and imperfect inspection. Cheap work in electric light equipment is not only nasty, but very dangerous."

Bradford Municipal Station.—The Mayor of Bradford (Alderman W. Moulson) last Thursday formally opened the electric lighting works which have been established by the Corporation, and which we alluded to fully last week. The following is an account of the proceedings on the day of opening. There were present Alderman Frederick Priestman (chairman of the Gas Committee), Mr. Skidmore (stipendiary magistrate), Mr. W. H. Preece, F.R.S., Alderman Hallett (Brighton), Mr. A. Siemens (of

the firm of Siemens and Co., London), Mr. Shoolbred (electrical engineer to the Corporation), and a large number of members of the Town Council. At the entrance to the works Alderman F. Priestman presented to the mayor a silver-gilt key. His worship having started the three dynamos the company entered another room, where the mayor briefly described the action of the Corporation in reference to the works. He said that, as the first municipal body in the kingdom which had ventured to have an installation of electricity, they had had to contend with difficulties such as generally beset persons who engage in new enterprises. They had, however, taken every possible precaution against mishap that experience could suggest, and they had been guided by the best electricians. The works had been placed in the centre of a compact district, and they had been so arranged as to allow of provision being made to meet any need for extending operations. Although six years had elapsed since the Corporation obtained power to construct such works, he did not think they ought to be charged with dilatoriness. On the contrary, by not enforcing their powers earlier, the Corporation had escaped the disaster which had fallen upon those who were in too great haste to enter upon electrical enterprises. He thought all present would be satisfied with the work which had been accomplished. Besides light for which it would be first used, he hoped to see an extended application of electricity for motive power. If the Corporation had failed to provide a supply of electricity, the matter would probably have been taken in hand by a company, with the result that in a few years there would have been a repetition of the difficulties experienced at the time when the supply of gas and water was under the control of private companies. His worship called attention to the great contrast between the present gas lighting in the town and the state when the gas was in the hands of a private company, and added that they had in this change a proof of the advantage of having public works under their own control. He considered that their experience in regard to the supply of water and gas justified the Corporation's action in reference to electricity. In requiring the cables to be laid in underground trenches, he thought the Corporation acted wisely, for although the method was more costly than the system of overhead wires, it had many advantages, and he hoped that telephone wires would ere long be carried under ground. In conclusion, he said the town was greatly indebted to Alderman F. Priestman, for the great services he had rendered as chairman of the committee in connection with the electric installation. In the course of the subsequent proceedings, Mr. Preece, in adverting to the danger connected with electricity, said he believed the continuous system adopted at Bradford would be absolutely safe. He regarded electricity as not opposed to the interests of gas producers; gas ought to be used for the production of heat, and if it were applied to working an electrical engine twice the amount of light could be obtained. Mr. F. Priestman said the committee did not expect that the installation would prove profitable for the next two years at least. The lowest possible price to be charged was 5d. per unit; and by fixing it so low the committee hoped to induce persons to become users of electricity. One great advantage of the Corporation's installation was that it would prevent any interlopers supplying electricity to the town. Mr. Shoolbred expressed his conviction that at Bradford there was also a wide field for the application of electricity in the treatment of sewage by the Corporation.

PURIFICATION OF SEWAGE AND CONTAMINATED WATER BY ELECTROLYSIS.*

BY WILLIAM WEBSTER, F.C.S.

When some months back your committee did me the honour of asking me to read a paper on the electrical treatment of sewage, I accepted the privilege with many misgivings, as, unfortunately, my time is so much occupied in the routine of business that I felt it would be impossible to prepare a paper worthy the attention of this assembly. Having accepted the responsibility, I have done my best to put the subject before you clearly, and must crave your indulgence for any shortcomings.

The increasing populations of our large towns has made the question of sewage purification a very pressing one, particularly in relation to the purity of our rivers, most of which unquestionably are in a serious state of pollution. The sewage question generally has become of such importance in reference to public health now and hereafter, that it is evident steps must be taken as quickly as possible to remedy the present condition of things, and to maintain as high a standard of purification as is compatible with the enormous quantities with which we have to deal.

It may be that the present scientific knowledge is not sufficient to entirely and finally deal with this question. We should, however, aim at as high a standard of purification as possible—it is of no use to try half measures—and whatever the treatment may be, my contention is that the nearer Nature's action is approached, the nearer the solution of the difficulty. Any new process requires thorough investigation, and it is for this reason that my experiments have taken up so much time; the success of certain laboratory experiments having been made public quite eight months before I was able to start a series on anything like a working scale, and since that time my connection with other undertakings has rendered it very difficult for me to concentrate attention except for short periods at intervals.

The oxidation of organic matter can only be attained by one mode—chemical action—whether it be by filtration, the addition of chemicals, or by mechanical force represented by the electric current.

Sewage is a most complex compound, whose component parts depend upon the water supply of a town, in some cases upon the rainfall and the industries of the locality. Householders and owners of factories would much assist local authorities in the end aimed at if they would disinfect their refuse before it passes into the sewers, thus one of the most objectionable features I have noticed in London sewage is the large amount of organic matter floating on the surface with an obnoxious odour. I am not quite certain of its source, but it evidently of a nature that points to gas works or tar distilleries, also certain dyes and tan refuse, which require more treatment than sewage itself. I know that the manufacturer is at a loss where to put his waste products, and it is an extremely difficult question for the public to solve; but it is a moral certainty that, if the sanitary authorities of our cities and towns have to purify their sewage, the taxpayer will decline to pay for the treatment of manufacturers' refuse when it is known that sewage alone requires very much less expenditure on purification than when it is mixed with complicated waste compounds of a chemical nature. The great object in view is to prevent putrefaction, and it may not be out of place to state the means of arresting it. The question is, what is putrefaction? Putrefaction is a spontaneous change common to all organic bodies when exposed to the air; the action is accompanied by the evolution of unpleasant gases, which are, for the most part, compounds of sulphur and phosphorus; it differs from decay, as it is not oxidation; the presence of air is essential only at the commencement of the action, and not after it has fairly set in. Modern science teaches us that air may be the carrier of ova which induce the change. Dry matter does not putrefy; intense cold prevents putrefaction.

The atmosphere acts mechanically by its power of removing foul vapours, and chemically by their oxidation.

Water—its action is largely mechanical. Thus in a river organic matter becomes separated, and oxidation takes place by reason of the air dissolved in it; showers of rain purify the air, and the molecules of water forming the rain act as carriers of oxygen.

The soil as manifested in our graveyards, the iron oxides in the soil acting as purveyors of oxygen, and owing to its porosity causes the oxidation of putrefying matter. Intense heat and light also play important parts in disinfection.

Sewage farms can only be successful when the porosity of the soil is adapted for filtration, and when the area is sufficiently large for the work it has to do; but all sewage before being run upon the land should be treated so that secondary putrefaction cannot be set up.

The organic matter should also be disintegrated, so that the pores of the natural filter shall not be blocked up by it when in a state of semi-solution. Greasy matters should be removed, as they also have a tendency to block up the soil.

Before entering into the particular subject of my paper, I must ask you to glance at the list of a few of the chemical processes which have been tried in various parts of the world during the last 120 years.

Name of Substances.	Inventor.
Sulphate of iron.....	Debois sieu 1762
Chlorine	Halle 1785
Lime	Estienne..... 1802
Powdered charcoal.....	Giraud 1805
Chlorine and chloride of lime	Guyton Morveau 1805
Ashes	Chaumette..... 1815

* Paper read before the British Association at Newcastle-on-Tyne.

Name of Substances.	Inventor.
Sand.....	Duprat 1818
Sulphate of iron	Briant..... 1824
Chloride of soda	Labarraque 1824
Waste chloride of manganese	Payen and Chevalier... 1825
Sulphate of lime.....	Siret 1827
Animal charcoal.....	Frigerio 1829
Peat	Guibourt and Sanson.. 1833
Charcoal and calcined marl, or river mud	Pottevin..... 1836
Sulphates of iron and zinc with tan and tar.....	Siret 1837
Earth, lime, and waste substances	Rossier 1837
Peat ashes	D'Arcet 1840
Metallic oxides and carbon	Krafft and Sneyet 1840
Chloride of zinc	Sir William Burnett... 1840
Schist coke	Hompesch 1841
Trade refuse, charcoal, and ashes	Albert 1842
Powdered lignite.....	Jourdan 1843
Impure alum	Siret 1843
Sulphate of zinc, charcoal, and clay ..	Gagnage & Regnault... 1844
Persulphate of iron	Baronnet 1845
Schist coke	Du Boisson..... 1845
Chlorides of iron and zinc.....	Dubois 1846
Lime and precipitating tanks	Higgs 1846
Nitrate of lead	Ledoyen 1847
Waste salts of iron, lead, zinc, etc., with pyroligneous matters, ashes, etc. ...	Brown..... 1847
Pyrolignate and perchloride of iron ..	Ellerman..... 1847
Impure chloride of manganese.....	Young..... 1847
Dried seaweed, lime, and sulphate of lime and zinc	Salman 1848
Peat charcoal	Rogers 1848
Charcoal, soot, mineral salts, etc.	Legras..... 1849
Spent tan, carbonised	Tarling 1850
Fresh bark, sulphate of iron, and peat charcoal	Angely 1850
Metallic sub-salts, as of iron, alumina, etc.	Browne 1850
Milk of lime and collecting the deposit	Wicksteed 1851
Acids and metallic salts, and filtrations through charcoal, clay, peat, gypsum, etc.	Dover 1851
Lime, sulphates of alumina, and zinc and charcoal	Stothert 1852
Lime, magnesian earth, sulphate of zinc or iron, and vegetable charcoal ...	Gilbee 1852
Sifted ashes, breeze, or peat charcoal ...	Perks 1852
Sulphate of zinc, potash, alum and sand with waste tan, ashes, lime, soot, etc.	Pinel 1853
Metallic sulphates, metallic chlorides, or charcoal and magnesian salts	Herapath 1853
Salts produced in working galvanic batteries	Dering..... 1853
Peat or bog earth containing salts or oxides of iron	Dimsdale 1853
Peat and other charcoal and chloride of sodium, etc.....	Marpherson 1853
Animal charcoal, alum, carbonate of soda, and gypsum	Manning..... 1853
Magnesia and lime with sulphurous and carbonic acids	Smith and McDougall 1854
Lime and finely-divided charcoal.....	Wicksteed 1854
Boghead coke	Herapath 1854
Soft sludge from alum works with lime and charcoal	Manning 1854
Peat charcoal carbonised with oil of vitriol	Longmaid 1855
Alum schist or shale, and other aluminous minerals, with lime and charcoal	Manning 1855
Manganates and permanganates	Condy 1857
Superphosphate of lime with magnesia and lime	Blyth 1858
Sulphate of iron with lime in solution (recommended only), etc.....	Letheby 1858
Spongy iron	Bischoff 1865
Iron finely divided in revolving cylinders	Anderson 1884
Iron sulphate	—
Aluminium sulphate	—
Calcium sulphate	Named Ferrozone 1887
Magnesium sulphate	—
Silica	—
Black oxide of iron.....	—

It is, I fear, true that many of the methods enumerated, and most of those not enumerated have not only failed to meet reasonable expectations as to their physical and sanitary characters, but they have also proved in many cases costly failures; and it is a remarkable fact that claims have been made within the last five years in reference to sulphate of iron by itself, or in combination with other materials, as if it had only just occurred to the chemical mind that these substances ought to be tried. On reference to this list you will notice that the first five, dating from 1762-1805, are practically identical with those of recent date. In 1843 alum seems to have been tried, and in 1857 manganates and permanganates; the latest development of sulphate of iron is under the name of ferrozone. It was while working with perchloride of iron as a purifier of sewage that I first learned the importance of iron salts in relation to organic matter, and it was in connection with this chemical and the chlorine gas that the idea of electrolysis suggested a possible mode of

treatment of water contaminated with organic matter. Sulphate of iron has one great drawback—the production of sulphide of iron due to the organic matter combining with the oxygen of the salt. In nature we have iron pyrites known as the bisulphide of iron, which is produced by the deoxidation of sulphate by organic matter. The sulphuretted hydrogen in sewage is entirely due to the same action on the sulphates contained in it; it therefore follows that sulphates should not be added, as they only increase the nuisance instead of abating it. Sulphuric acid added to manganate of soda and run immediately into the sewage is sure to lead to objectionable reactions. The very fact of adding chemicals means adding water, thus, to a certain extent, producing a seeming purification. The following illustration will show this:

Ten grains of lime added to a gallon of sewage in the form of lime water means the addition of one pint of water, it therefore makes an apparent purification of 12·5 per cent. by this increase of water. I have here a list of analyses taken from the Appendices of the Report of the Royal Commission on Pollution of Rivers. My experience being that lime produces after putrefaction if used alone or with sulphates, and if used in large quantities is also sure to set up after precipitation when the resulting effluent is run into river water.

I have already stated that putrefaction means sulphuretted hydrogen. On the West Coast of Africa the water contains large quantities of sulphuretted hydrogen, its formation being due to the presence of organic matter and sulphates. I believe I am right in saying that this particular portion of the African coast is known as the Sailors' Death-trap.

Of artificial disinfectants chromic acid is the strongest, sulphurous acid the weakest among mineral acids. Permanganates oxidise dead organic matter under certain conditions, but unless in very concentrated solutions, have little or no action on disease germs. Chlorine gas or oxides of chlorine are the most powerful disinfectants.

The fact that water is easily decomposed provided the current of electricity is of sufficient intensity, and also that the effects produced are precisely in accordance with the chemical equivalents of the substances electrolysed, is practically the explanation of the whole system; for the chemical changes that take place in sewage when it is electrolysed depend chiefly on the well-known action that sodium, magnesium, and other chlorides (which are always present in sewage) are split up into their constituent parts. Thus we have at the positive pole chlorine and oxygen set free, and these elements are liberated in a nascent state, a condition in which they are intensely active, so that the organic matter in the sewage is rapidly oxidised into innocuous compounds. So rapid is this action that, provided the sewage contains a sufficiency of chlorides, it is possible to produce a disinfecting fluid from it consisting of oxides of chlorine.

As mine is an artificial action I will take the two disinfectants which are formed in my process, iron oxides and chlorine. The first a purveyor of oxygen, the second in the form of hypochlorites or chloric acid, absolutely destroys organic matter living or dead. By using non-oxidisable plates, such as carbon for positive pole and iron at the negative pole, with a porous diaphragm between them, I am able to collect the component parts of the mineral salts; therefore at the non-oxidisable plate I obtain a solution of chlorine and oxide of chlorine, and at the negative plate I obtain ammonia, soda, and potash, which in their turn precipitate any lime and magnesium salts that may be present in the liquid. So strong is the action of oxide of chlorine that it is only one form of carbon plate that will resist disintegration.

My first experiments carried out in this manner were conducted with platinum plates, but the experience was that the cost of platinum put it out of the question, besides which there was a very slight action on the positive plate which distinctly pointed to its ultimate destruction, there being no precipitation in the sewage of matters in suspension. By means of an arrangement which consists of a porous pot with a non-oxidisable plate—such as carbon for the positive electrode and iron plates for the negative electrodes—I am able to manufacture the before-mentioned solution of oxides of chlorine from brackish sea water or sewage. The water of the River Thames near Barking is admirably suited for this purpose. It is possible that an objection may be raised that the resistance of the porous pot to the electric current would be so great that the cost would render it an impossibility from a commercial point of view, but the very fact of using salt water balances the extra resistance caused by the porous diaphragm, and for every ampere of current that is used per hour I produce 18 grains of nascent chlorine, or an equivalent of the oxides of chlorine. My experience of nascent chlorine as a disinfectant is that about one-third of a grain is capable of disinfecting one gallon of London sewage (first removing the matters in suspension) and on examination the presence of nitrites is detected, which shows how far the oxidation has been carried. This action, combined with the treatment with iron plates, hereafter described, will, if carried far enough, absolutely eradicate all organic matter. And here it will be as well to mention that the resulting effluent must not have an acid reaction, otherwise fungoid growths appear on the surface after a few hours. The forms in which these apparatus are best applied on a small scale, with porous diaphragms, are as follows: First, an outer vessel, which may be made of iron—the sides in that case acting as negative electrodes—and an inner vessel containing the carbon electrode. By means of a syphon connected with a reservoir or tank, containing, say, sea water or salt and water, the inner vessel can always be kept supplied with the saline solution, and by an easy automatic arrangement it is possible to draw off a given quantity of disinfectant solution when formed. By placing an oxidisable plate in the same pot as the carbon, and connecting the two to the positive pole of the current, I can produce a hyperchlorite or chloride of the metal used which will thus further assist the resulting action. The many uses to which these disinfectants can be applied I need not enlarge upon. Six small cells of the latest form of the Leclanché type are quite sufficient for producing the necessary power

for making two or three gallons of the chlorite solution during the day, and they will last for several months without recharging, it being understood, of course, that they do not remain continuously in action. The apparatus on a large scale may be variously modified according to the strength of the solutions of chlorides acted upon.

By applying the current to a carbon filter I am able to oxidise the organic matter in water. The positive pole being the porous carbon block, the nascent oxygen produced in the pores of the carbon by the electric current absolutely destroys the organic matter; bacteria being killed and the filter-block itself kept clean. The action of porous carbon by itself is due to its power of absorbing noxious gases and effecting their destruction by bringing them into contact with atmospheric oxygen, but it is absolutely essential that there should be a free supply of air; how much more active the action is when nascent oxygen, and even chlorine, are constantly supplied to the pores of the carbon by means of the electric current, can be easily imagined. As an example, the following analysis before and after action may be of interest:

FILTER EXPERIMENT ANALYSIS.—Parts per Gallon.

	Appearance.	Odour.	Oxygen required to oxidise the organic matter.
Before action—Dilute sewage	turbid	bad	0·93
After action—Nitrates present ...	clear	none	·17
Before action—Contaminated water	slightly turbid	slight	·06
Before action—Contaminated water	clear	none	·00
After action—Dilute sewage	turbid	bad	0·82
After action—Ordinary carbon filter	slightly turbid	slight	0·4
After action—Electric carbon filter	clear	none	0·13

Current used, 0·5 ampere.

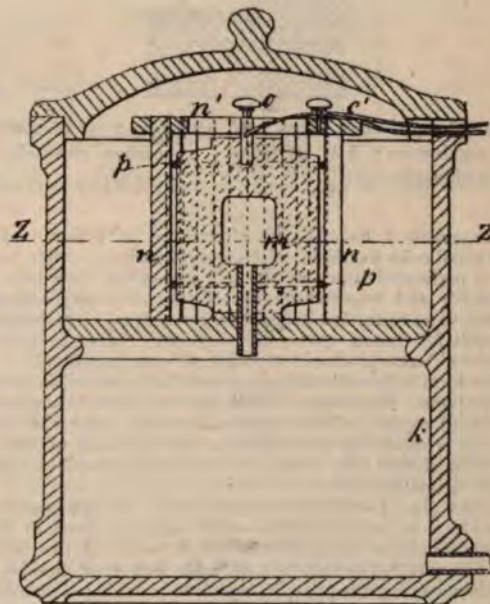


FIG. 1.—Filter. *cc'* show wires to battery; *m* positive electrodes; *nn* negative electrodes; *pp* non-conducting strips; *k* containing vessel.

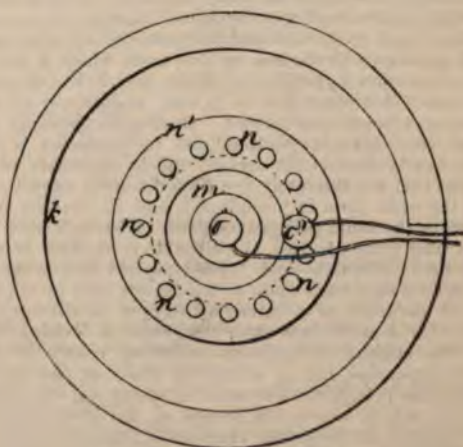


FIG. 2.—Section on line Z Z.

For the purposes of this filter, an ordinary form of stoneware, divided so that the lower compartment contains rather more than the

red. In this case the sewage, after action with the iron electrodes, is allowed to flow into a settling-tank, and after remaining for an hour for the precipitate to subside, the effluent is passed through the filter, any oxide of iron that may be present tending to form the top layer of filtering medium free from any objectionable matter, and in turn forming a filtering medium. As the filter contains no material, and does not require any additional engine power, using it the electrolytic action with metal plates not being so far, the cost of working need not be considered. When a sufficient amount of oxide is deposited on the top layer of sand, it can be removed, allowed to dry, and sold to gas works. The resulting sludge contains 16 per cent. of iron oxide, which does not represent the waste plates alone, for, in London sewage, the wear and tear of the wheels, horses' shoes, etc., in the streets means oxide of iron in its composition. One sample taken some months back contained no less than six grains iron oxide in the gallon before treatment.

Henry Roscoe has kindly consented to my quoting a few facts from his report and the analyses made by him during the filtration of this process. He states:

The quantity of sewage operated on in each experiment was 20,000 gallons.

The reduction of organic matter in solution is the crucial test of value of a precipitating agent, for unless the organic matter is reduced the effluent will putrefy and rapidly become offensive. I have observed in any of the unfiltered effluents, from this process, that I have examined, any signs of putrefaction, but, on the contrary, a tendency to oxidise.

The absence of sulphuretted hydrogen in samples of unfiltered effluents, which have been kept in stoppered bottles for three weeks, is a fact of importance.

The settled sewage was not in this condition, as it rapidly undergoes decomposition in two or three days, even when in contact with air.

By this process the soluble organic matter is reduced to a condition favourable to the further precipitation by natural agencies."

SIR HENRY ROSCOE'S ANALYSES.

No.	Percentage reduction of oxygen required to oxidise organic matter.		Albuminoid ammonia.
	67.4	57.0	
1	67.4	57.0	
2	64.3	57.3	
3	77.2	75.0	
4	72.6	50.0	
5	76.5	87.5	
6	73.0	87.5	

other series of experiments carried out by Sir H. Roscoe, which are tabulated (diagram), show an average reduction of 60 per cent., though the full treatment was not carried out.

I have also other lists of analyses by Dr. Meymott Tidy and Mr. Winter, which show equally favourable results.

I have also tabulated analyses of my own, carried out in 1886, showing the electrolytic action on contaminated canal water (diagram). These are analyses of samples taken from each section of the shoot—being six in series—the organic matter is seen to be gradually reduced by the electro-chemical action.

I have never seen an effluent treated in the way described show any of secondary decomposition, nor develop sulphuretted hydrogen. Cases where specially prepared or suitable land of a porous nature curable the effluent might be wholly or partially used for manure, in which case the sewage should be only so far treated that the prevention of putrefaction is assured.

The advantage of iron in the soil is one which I think every practical man must acknowledge. I had some sludge (deposit after electrolytic treatment) pressed without the addition of lime, and it was used to vegetables, the result being that a marked difference in the growth of iron manure was shown in the crops when compared to those grown with ordinary farmyard manure.

The question of sludge disposal is a difficult one, and as my paper is essentially electrical, I will only mention that I should, where possible, puddle it with chalk, and run on to waste lands, through open conduits, similar to the process of mixing clay and chalk in a pug mill, and running into backs, as carried out in cement manufacture, the only alternatives being filter-pressing or shipping to sea.

The bacteria question is one which has probably still to be settled; being anxious to have some information as to the action of the compound produced by electro-chemical decomposition, I had experiments carried out, with the result that after a given treatment the whole of the bacteria were killed. In the case of experiments carried out in Paris, with ordinary treatment by means of iron electrodes, the results were as follows:

	Raw sewage.	Effluent.
Organisms per cubic centimetre	5,000,000	600

In another experiment in which the effluent was treated still further, at a slight odour of oxide of chlorine was perceptible, destroyed organisms, and the liquid remained sterile.

In conclusion, I submit that the application of the electric current in several ways I have endeavoured to describe produces a precipitating and oxidising action similar to natural processes, in which organic matter is destroyed by oxidation due to dissolved oxygen absorbed from the air, assisted in many cases by matters in the effluent such as oxides of iron, acting as carriers of oxygen, and I also submit that the question of cost will bear favourable comparison with any process which really does the work attributed to it.

A number of tables similar to the following were shown by the author:

UNTREATED SEWAGE.—Treatment with iron electrodes only. Effluent suitable for large rivers, etc.

	Dissolved solids. Grains per gallon.			Ammonia. Grains per gal.		Chlorine. Grains per gallon.	Oxygen absorbed from K Mn O ₄ .	
	Total.	Mineral.	Organic.	Free and saline.	Albuminoid.		3 min. at 60 deg. F.	3 hrs. at 60 deg. F.
No. 1	78.05	54.18	23.87	3.22	1.14	15.40	7.62	4.84
No. 2	69.44	47.95	21.49	3.00	0.56	14.98	0.98	4.19
No. 3	78.75	53.83	24.92	3.44	0.74	17.64	1.85	4.90
No. 4	68.74	48.79	19.95	2.31	0.52	14.56	1.75	4.69
No. 5	75.04	52.64	22.40	2.45	0.56	16.45	2.10	4.62
No. 6	72.10	54.67	15.43	2.28	0.52	18.20	2.10	4.55

EFFLUENT.

No. 1	67.20	51.66	15.54	3.08	0.45	13.30	0.98	2.89
No. 2	63.98	49.72	14.26	2.96	0.41	14.77	0.63	2.12
No. 3	71.68	52.50	19.18	3.23	0.36	16.10	0.74	1.67
No. 4	61.60	40.74	20.86	2.21	0.22	13.16	0.66	1.61
No. 5	63.35	43.33	20.02	2.45	0.21	15.40	0.77	1.47
No. 6	65.94	48.30	17.64	1.92	0.28	17.78	0.70	1.69

FILTER ANALYSIS.—Small Household Filter. Current used, 0.5 ampere.

	Appearance.	Odour.	Oxygen required to oxidise the organic matter.
Dilute sewage	Very turbid.	Bad.	.82
After ordinary filter	Turbid.	Slight.	.4
After electric filter	Clear.	None.	.13

TELEPHONIC COMMUNICATION BETWEEN LONDON AND PARIS.*

BY W. H. PREECE, F.R.S.

The practicability of speaking by telephone between London and Paris has recently been carefully examined both by the French and the English electricians. The distance between the two places is 275 miles—viz., 74 miles between London and Dover, 21 miles from Dover to Calais, and 180 miles from Calais to Paris. It is very easy to speak over such a distance if the wires be aerial and of thick copper, but the insertion of underground wires at each end and of a cable in the middle, place difficulties in the way that have to be surmounted. It is not a question of apparatus, it is solely the distribution of the electrical resistance and capacity of the different portions of the line, and the arrangement and material of the wires.

Speech is already commercially maintained between Paris and Brussels (190 miles), Paris and Lille (158 miles), Paris and Rouen (80 miles), Paris and Havre (135 miles), Paris, Lyons, and Marseilles, the latter being a distance of nearly 600 miles; but in all cases they are aerial wires, excepting for a short length (about two miles) of underground work in Paris.

The author has experimented on the cables between Dover and Calais, between Holyhead and Dublin, and between South Wales and Wexford. The conditions to be fulfilled are very simple. The circuit must be metallic, the material must be copper, and the product of the resistance of the line, R, and its capacity, K, must not exceed a certain figure. It had been determined roughly, by experiment, that when—

K R = 15,000	speech becomes impossible.
" = 12,500	" possible.
" = 10,000	" good.
" = 7,500	" very good.
" = 5,000	" excellent.
" = 2,500 or under	" perfect.

We have thus a species of Beaufort's scale applied to telephonic communication.

A circuit approaching as nearly as possible one between London and Paris was made on an artificial cable, and it was found to comply with the requirements. An actual circuit was then made from Worcester through 27 miles of the London underground system to Baldoek, on the Great Northern Railway, giving similar electrical conditions, and with the same result.

It may be considered as absolutely settled that speech is possible between London and Paris.

In the United States speech is maintained between New York and Boston, 350 miles, and in many instances to distances exceeding that between London and Paris, but they have not to surmount the difficulties of underground wires at each end, and of a cable in the middle.

* Paper read before the British Association at Newcastle.

THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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IMPORTANT NOTICE.

We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No paper that we know ever refuses Subscribers or Advertisers. Nor do we; in fact, we invite them, believing that they will get full value for their money.

Specimen copies of the paper will be sent on request.

"WHERE IGNORANCE IS BLISS"—

Oh! that mine enemy would write a book, is the cry of the litterateur; oh! that mine enemy would make a speech, is the cry of the enthusiastic politician; oh! what a blessing is the abstract of a scientific discussion by the ordinary reporter to the weary paragraphist. With what avidity the latter writes a sneering, biting diatribe about something the scientific speaker never thought or imagined, much less said. What a wealth of invective has been hurled against the unoffending head of Mr. W. H. Preece for what he never said at the last meeting of the British Association, so much, indeed, that he has found it necessary or expedient to write to the *Times* complaining of his critics' inaccuracies and attempting to correct them. He might just as well attempt to dam the ocean, for a correction only half palliates the offence. We look upon these gross inaccuracies in another light, and do not hesitate to say they are a disgrace to nineteenth century journalism. Non-technical papers cannot be expected to be able to discuss mechanical or scientific details, but they might be expected not to pervert a simple statement. The paper of Killingworth Hedges, under discussion, met with approval in one part and disapproval in another from Mr. Preece, who, while speaking, uttered some good-humoured but withal exceedingly true remarks about one of the laws passed by an American state to supersede hanging by killing by electricity. He stated what is perfectly true, that our scientific knowledge is at present too crude to enable us to say with certainty what current or voltage will painlessly kill a man, and also remarked that many of the fatal accidents attributed to electricity were probably due to some other agency, instancing as an example of this uncertainty the recent fatal case at Brighton. The tendency of the remarks was perfectly clear to every man present possessing a modicum of scientific knowledge, but it seems that there were present some who, deficient in this respect, made up for their deficiency by attributing to the speaker some widely different statements. One paper triumphantly refuted its statement of what Mr. Preece said, which was to the effect that no one ever had been or could be killed by electricity, by printing in juxtaposition with the statement an extract from an American contemporary detailing such a fatal accident. Well, Mr. Preece has, as we say, written his contradiction, but the escapade should open the eyes of all connected with the electrical industry to the ignorance which reigns supreme "in the vulgar tongue" upon matters electrical. It is this ignorance that acts as a drag upon progress, that rings in sonorous undulations in vestry meetings to the effect that "we must not endanger the ratepayers' money in attempting to carry out work which as yet, yea, even yet, has not passed the experimental stage."

Experimental stage forsooth. Where, except in eating and drinking, are we out of the experimental stage? Are the designs of our warships settled to all eternity, or are they fleeting as the wind? Are we to stop building ships because ignorance claims those built as experimental only? The first ocean steamship before it crossed the Atlantic might, perhaps, be termed an experiment, but when it had crossed and recrossed the ocean it was an experiment no longer. So with electric lighting. The matter, whether with central station or with isolated plant, is no experiment, it has long passed that stage, though its possibilities and eventual developments may be hidden in the as yet untrodden depths of the unknown. How to overcome the bad effects of the existing ignorance is a problem of importance, and difficult to solve. The mathematician is powerless, but something may be done by influencing the non-technical press to mend its ways and avoid giving currency to erroneous opinions.

So far as the British Association reports are concerned it would be far better to diminish the sums annually voted for this or that purpose, or pretence at a purpose, and each year to devote three or four hundred pounds to furnish the ordinary newspapers with correct reports of what is said or done at the meeting. If the Association performs no educative function to popular audiences, or if its proceedings are twisted contrary to facts, the sooner it follows the footsteps of the Social Science Congress and ceases to exist, the better. At present it is supposed to perform a certain modicum of valuable service, to create a greater interest in scientific matters in the district in which it meets, but when what is said is wrongly reported a large part of the benefit is lost, and the last state of those who look to it for enlightenment is worse than the first. There is hardly a paper throughout the kingdom which has not misrepresented Mr. Preece's speech. The members of local authorities will probably take to heart what they have read, and for weeks and months, if not for years, those who know better will have a lively time in contradicting the evil report. It is astonishing how long an error clings, and although one might argue that in this particular case the erroneous idea would be beneficial rather than the contrary, it needs but the most cursory thought to show this notion to be wrong. The difficulties to be encountered in making distributing systems safe, both as regards life and as regards fire, must not be ignored. We have to insist upon good designs and excellent workmanship. Mr. Preece was really insisting upon the necessity of taking precautions, when according to the reporters he was pooh-poohing danger. The greatest trouble likely to arise is from the process of cheapening down due to competition, and if the idea once obtains that precautions may be neglected there is a danger of anxiety to get work leading to

this neglect, hence the impossibility of letting the matter pass without challenge. There are enough differences of opinion between electrical engineers as to the use of high or low pressure, batteries or transformers, but there is no difference as to the advisability of taking every precaution necessary to prevent accident to life, or to prevent fire.

LITERATURE.

Electricity in our Homes and Workshops: A Practical Treatise on Auxiliary Electrical Apparatus. By SYDNEY F. WALKER, M.I.E.E., etc. Illustrated. Whittaker and Co., Paternoster-square.

The author of this book will forgive us if, instead of discussing its merits and its demerits through the whole range of chapters, we pay attention more particularly to that part which deals with the subject of which he has made himself master, and information upon which is vainly sought for elsewhere. This book, then, while dealing with various auxiliary apparatus, has one portion devoted especially to electric mining signals, a subject in which the author possesses great experience. It would be useless to enter into any discussion as to the value of such signals in mining operations. The best authorities—that is, the managers and owners of mines—admit the superiority of such a system over any other, and its introduction in all mines is simply a question of time. It is to this part of the book, then, that we direct attention, and readers will find that the faults of early workers are explained, and how these faults have been remedied till recent arrangements leave little to be desired. There is one feature of importance throughout the whole of the book, and it is that the author never hesitates to say why a particular design or piece of apparatus has been adopted, which to the uninitiated seems cumbersome or unsuitable for the work. In mining work, it is no use installing drawing-room apparatus—something is wanted that will stand fairly rough usage. The whole of this part of the book is, as we say, the result of personal experience, and, as such, should receive careful attention. No doubt feather-bed electricians who have never seen a mine will stand aghast to find the pet theories evolved in school books treated somewhat cavalierly in such language as the following: "This is a case, of course, that would rarely or never occur in practice. It is introduced here in order to explode a fallacious argument that is given in nearly all the textbooks as to the proper method of connecting cells so as to get the best results." Again, this book will appeal to the popular taste. It speaks in ordinary language, and can be understood by the veriest tyro.

THE SAVOY HOTEL.

It has become a recognised thing that any new building of importance, be it hotel, theatre, church, or music hall, must be electrically lighted; and in the Savoy Hotel, just lately opened on the Victoria-embankment, the very latest development of hotel lighting may be seen. It is encouraging to find that after some years' experience of electric lighting at the Savoy Theatre, Mr. D'Oyley Carte, the managing director of the hotel, has so much confidence in this form of illumination that the only gas used or laid on in the hotel is that for cooking purposes. The installation consists of four large boilers, two Lancashire and two Cornish, set in brickwork on Livet's patent system, supply steam at 120 lb. pressure to four Willans engines driving Siemens dynamos, the engine and dynamo being mounted together on Willans patent combination bed-plates. Of the dynamos, three give each a current of 900 amperes, and the fourth a current of 450 amperes, this latter being run during the daytime, so that there is a constant supply of current at all hours. The voltage is 110. The main switchboard, fixed in the engine-room, consists of a slab of marble in a teak frame, surmounted by a clock, and

fitted with a main switch for each dynamo, and also a main switch for the Savoy Theatre, which is now run from this installation. The dynamos, by means of these switches, can be connected in parallel, or any one or more dynamos put on to the various circuits starting from the board. There are also 11 switches connecting the sub-circuits to the dynamo-bar on the board, and each machine has its own ammeter. A voltmeter is fixed near each engine, and the volts are kept constant on the shunt-wound dynamos by means of variable resistances regulated by rheostats on the switchboard.

The exhaust steam from the engines is passed through Berryman heaters, and supplies hot water to the boilers, bath-rooms, sculleries, kitchens, and heating apparatus throughout the building. This use of the exhaust steam has the effect of almost eliminating the coal bill chargeable to electric lighting, as nearly the same amount would be burned for heating and cooking purposes were there no engines in the building, and shows the great economy that may be obtained in large installations of this kind. The number of lamps in the hotel is 2,000, and in the Savoy Theatre rather more than 1,000. There are 11 sunbeam lamps in the hotel, and two arc lamps in the theatre in addition to this. The original machinery for lighting the Savoy Theatre occupied the space now taken up by the boilers of the present plant, and Messrs. Verity promised that the theatre lighting should not be stopped for a single hour whilst the change was made. This promise they succeeded in keeping perfectly, and there has not been a moment's interruption to the lighting. It is proposed to further reduce the cost to the hotel company of the electric lighting by supplying current to neighbouring premises, applications having already been received, and as there is plenty of spare power available this arrangement will fit in very well.

The ventilation of the engine-rooms, etc., is effected by means of a 5ft. diameter "Verity's silent air propeller," driven by an electromotor, and its speed regulated by means of an adjustable resistance. In addition to the electric light machinery, there are two sets of deep well pumps, driven by separate engines, and raising water from a well 420ft. deep; also two large Worthington pumps, which fill the tank on the roof for working the elevators. Of these latter, there are two very fine ascending rooms for passengers and four service lifts, all electrically lighted. The system of distribution employed has been to run a pair of separate mains to each floor. From these, branch distributing mains are carried round the corridors in casing, which is moulded to form a member of the cornice. A pair of wires are carried through a double-pole cut-out into each room, and then distributed to the different fittings. Every room is provided with a portable standard for reading, writing, etc., and all the lights are shaded in such a way that there is no glare, but a soft diffused light. The fittings are very artistic, and some of the large rooms, with their handsome and expensive decorations, present a most striking appearance of comfort and elegance. The installation has been carried out by Messrs. B. Verity and Sons, of Covent Garden, in a way that reflects great credit on all concerned.

NEW YORK NOTES.

(FROM OUR SPECIAL CORRESPONDENT.)

*The Telephone Convention.
Interesting Papers.
New Edison Station at Brooklyn.
A Model Central Station.
Young Men Prominent in Electrical Work.
The Pacific Cable Scheme.
An American Company to Work It.
Facts and Figures.
Electrical Interests in Court.
Telephone sues Electric Tramway.
"Inexperience and Carelessness."
Police Signalling-Boxes.
The Great Storm; Telegraphs Suffer Severely.
Vagaries of a "Dead" Wire.
Major Grant's Temper Rises and the Companies Suffer.*

NEW YORK, September 14, 1889.

The interesting electrical event of the week is the Telephone Convention, now taking place at Minneapolis. A large number of delegates from New York, many of them

accompanied by the ladies of their families, have gone West in a special train. A stoppage of several hours was made at Chicago, where the New York delegates were handsomely entertained by the officials of the Chicago telephone companies.

The subjects to be brought forward at the convention are of a highly interesting nature, and telephonists in general cannot but benefit by the publication of the papers and the discussion thereon, but it seems doubtful whether such publication will be made, at least as regards some of the papers or discussions. This does not seem entirely unreasonable, as the expiration of existing patents looms up ahead, and further litigation seems to be threatening; telephony is a branch of electrical science pre-eminently connected with secrets and surprises. Probably one of the most interesting papers laid before the convention will be that entitled "A New Era in Telephony," by A. S. Hibbard, F. J. Carty, and F. A. Pickernell, of the Long Distance Company. Mr. J. C. Reilly, of the Brooklyn Exchange, will read a paper on "Underground Wires," with which he has had much experience. Mr. W. D. Sargent, a prominent telephone man, who has just returned from Paris, will give us the benefit of his "Observations."

The new Edison station at Brooklyn has just commenced work, although the building, which has been erected in the short space of 90 days, is not yet quite complete in all its details. This central station is a model one in all respects. The steam plant comprises 12 Ball engines of 300 h.p. each, and eight Babcock and Wilcox boilers of 450 h.p. each. These engines, which are the latest development in special types for electric light work, are to drive 24 1,500-light Edison dynamos of the most improved pattern, weighing 10 tons apiece. The circuits are exclusively underground, on the three-wire system, and 25 miles have already been put down, covering quite a large district, extensions to be made as required. The steam plant is arranged with a view to preventing a breakdown from any ordinary cause, everything, even to the steampipes, being duplicated. Electricity is employed to work the lifts and other accessory machinery in the building, and the entire plant is considered to be the most perfect yet installed for central station purposes.

A noteworthy feature of this concern is that it is managed entirely by young men, who have had complete charge of the construction, and will have of the operation of the station. Quite a remarkable feature of the electrical profession in this country is that on all hands we find young men filling responsible positions, and filling them uncommonly well. One can scarcely fail to notice when visiting the offices or works of large electrical companies, that while the clerks and bookkeepers are generally middle-aged, and often quite elderly men, the superintendents, engineers, and electricians—and sometimes even the general managers—are as a rule young enough to be their sons. And now the great colleges are instituting courses of electrical engineering to turn out a fresh supply, who will naturally rank as grandsons.

The Pacific cable scheme is attracting much attention just now, and it seems as if the cable will be laid before very long. The committee of the San Francisco Chamber of Commerce, appointed to investigate the cost and feasibility of the scheme, have submitted their report. They calculate the entire cost would be £2,000,000, and they propose asking the U.S. Government to guarantee 3 per cent. per annum on this amount, a company to be formed under the laws of the United States. The total length of the line is estimated as being 6,371 miles, and the deepest water on the route, 4,428 fathoms. The cost of telegraphing, at present, from San Francisco to New Zealand varies from 12s. to about 13s. 8d. per word. It is estimated that the proposed cable would introduce a rate of about 3s. 4d. between Sydney and London.

The Bell Telephone Company, at Cincinnati, have filed a suit in the courts there to recover heavy damages from two electric tramway companies, and to obtain an order compelling them to so arrange their circuits as not to interfere with the proper working of those of the telephone system. Telephone communication with various points in the vicinity of Cincinnati is almost impossible, owing to induction set up in the telephone wires by those carrying

the heavy currents necessary to operate the electric tramways. The Bell Company is said to have a plan, which, if adopted by the tramway companies, would entirely do away with the evil complained of. It is intended to make the Cincinnati action a test case, as the Bell Company is suffering from a similar obstruction to its business in other cities.

A death from electricity occurred in Buffalo last week. A lineman, named Ferry, was up a pole, and, receiving a shock from the uninsulated part of the pliers with which he was holding a wire, he caught hold of the other wire near the insulator, where the covering had probably been worn off by the binding, thus interposing himself in a circuit carrying a current at 2,000 volts pressure. The unfortunate man lived 45 minutes, after hanging for nearly as long on the wires before they were cut and he could be taken down. His suffering was described as being very great. "Inexperience and carelessness—nobody else to blame," was the jury's verdict, after a lengthy inquest.

It is expected that the Police Commissioners will shortly decide upon the general adoption of a system of signalling-boxes to be placed at various points in the streets of New York for the purpose of enabling policemen on duty to communicate with the stations and *vice versa*. The systems which have been brought most into relief are two. One is a simple sentry-box containing a telephone in connection with the district station house. When the superintendent of the station wishes to call the attention of the policeman on his rounds a coloured globe is made to emerge from the box and enclose the lamp overhead. The constable then simply has to enter the box and speak by telephone to the inspector at the station-house. The other system considered is the Herzog "Teleseme" apparatus. This system came very near to being adopted by the Police Commissioners last year, but was finally rejected, partly because its complication was great and its range of usefulness limited. Now a new competition will have to be held, and it is expected to take place very shortly.

New York and the vicinity have been visited by a severe gale and heavy rainstorms, which have already lasted four days and show no signs of abating. The damage to property at the seaside resorts near New York and on the Jersey coast has been immense, and the telegraph lines have suffered to a great extent, in many places poles and all having been blown down; a telegraph cable crossing the East River was broken on the first day of the storm. Sandy Hook and many other places have been entirely cut off, and all the way from Cape Hatteras north there has been a great deal of trouble. The Western Union have a force of over 500 men at work repairing the lines, and the storm will cost that company many thousands of dollars. In some places the men have found it almost impossible to work, the poles being blown down as fast as they were put up, and often with men on them. The driving sand, blown upon the men in clouds, added so to their discomfort that many refused to work until the gale abated. Even when this occurs it will be days before all the lines are in working order again.

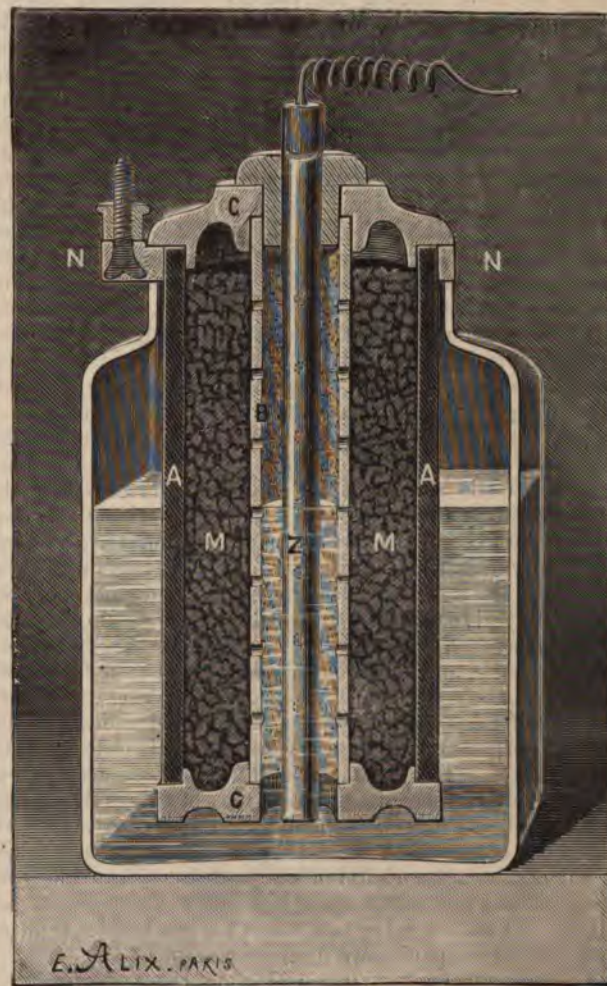
In New York city but slight damage has been done either to the wires of the Metropolitan Telephone Company or to the long-distance wires. Two accidents have occurred through the breaking of electric light wires, the broken ends of which, falling upon tin roofs, charged all the metal work in the immediate neighbourhood, and administered lively shocks to all unwary investigators of the cause of sundry sparks and blue flames that began to appear. In each case a slight fire resulted, but the fire department prevented any serious consequences. One of these exciting incidents was caused by a wire supposed to be "dead," but which was evidently very much alive.

Mayor Grant was exceedingly angry at yesterday's meeting of the Board of Electrical Control. He said that the messenger call companies still continue to string wires without even going through the form of asking for a permit. He knew this to be so because a company had offered to put up a call-box in the mayor's own house, and when he asked to see the permit, the company's representative laughed at him. This was certainly aggravating, but there was more to follow. An electric light company asked permission to string a wire, in addition to the eight it now has, to connect its plant with the

cables in the subway. The mayor almost exploded with wrath when he learned that the plant and the cables are just six miles apart! So great was the mayor's indignation at this application, that he told his associates on the Board that if they granted the permit, he would not vote against any future ones. Perhaps this would be "a consummation devoutly to be wished for" by the companies. The mayor also fell foul of the Subway Company, and refused them permission to lay subways except in the streets which are to be repaved, on the ground that the company was advised long ago that all work must be completed by December 1, and three months were allowed to elapse before the company began operations, and then excuses for slow work were frequently offered because of failure to obtain material. Nevertheless it seems hard to take companies' wires down from the poles and then to deny them permission to put them underground. What with Mayor Grant's energy and his temper the unfortunate electrical companies are, colloquially speaking, between the devil and the deep sea.

THE LACOMBE BATTERY.

A new form of agglomerate cell has been introduced by Messrs. Lacombe and Co., of Paris and Westminster. In



The Lacombe Battery.

this the usual position of the zinc is reversed. The zinc is placed in the centre in a small porous tube. Outside is a porous carbon cylinder which acts as one pole, and the depolariser of coke and manganese peroxide is packed in between. It offers some advantages over the usual form with porous pot, and has achieved considerable success in France, where it is now largely used. The arrangement adopted causes the hydrogen as it arises to cross the depolariser, and the small distance to the zinc also reduces the internal resistance. The battery is stated to give an undiminished E.M.F. for a much longer period than the old form and to have given very favourable result in practice. It seems a compact and serviceable form of battery.

Messrs. Lacombe and Co. are also introducing a new exciting salt for use in zinc carbon batteries, for which they claim advantages over the ordinary salammoniac, as it gives a perfectly clean wear of the zinc, preventing creeping and the formation of crystals.

THE ELECTRIC LIGHTING OF LONDON.

For the past week the *Daily News* has been giving a series of articles, in which it has been educating the popular mind to the beauties and the progress of electric lighting. The last article, No. IV., gives an account of the visit of Edison to the works at Deptford, of which the following is an abstract:

In accordance with private arrangements made on the preceding day, Mr. Edison visited the Deptford works of the London Electric Supply Corporation yesterday (Wednesday) morning. In front of the works there was a gay and liberal display of bunting, in honour of the distinguished visitor. Among those who accompanied him from town, or who were on the spot to meet him, were Sir John Pender, with whom Mr. Edison has been staying during his short visit; Mr. Forbes; Mr. Ferranti, the London Company's engineer, whom we have dubbed the Edison of England; Colonel Gouraud, Mr. Verity, Mr. Pender, Dr. Hopkinson, Mr. Gordon, Mr. Ince, Mr. Pike; Mr. Claremont, of the Metropolitan Company; Mr. Cunliffe Owen; Mr. Bain; Sir Coutts Lindsay, of whose place in the history of electric lighting we have formerly spoken; and the present writer. It was a delightful day—for a sharp walk, but the wind from the river "bit shrewdly." Mr. Edison felt it, for he was still suffering from his severe cold. He looked a dozen years older when, escorted by Mr. Ferranti and Sir John Pender, he entered the gateway, with his coat-collar up to his ears, a white muffler about his neck, and his hands stuck in his pockets. His face was much paler than usual. But he soon appeared to forget his indisposition when he began his inspection of the wonderful machinery. He spent a long time minutely examining the immense engine and dynamo which, it is hoped, will in a few days begin to supply lighting current over one section of the London region which has been assigned to the company. But as to the outfit of the works, as they will be several months hence, when the 10,000 h.p. engines are erected in the lower area of the building, Mr. Edison could only infer what it will be from the plans on the spot and from Mr. Ferranti's description. The diameter of each of the huge dynamos yet to be erected will be no less than 42ft. And each dynamo will be composed of a circle of 192 enormous magnets. Mr. Edison went over the whole ground to the river front of the works. A long way behind the Isle of Dogs, and nearly opposite the hospital, loomed the unadorned Brobdignagian form of the biggest gasometer in the world. The gasometer and Mr. Edison are symbols respectively of the old and new orders of things illuminant, but though the Edisons and the Ferrantis are taking the shine out of the gasometers, they are not necessarily taking it out of gasometer shareholders' pockets. That big gasometer, I was told on the spot, is about to increase its premises. There are many other uses for gas besides lighting, and the gas companies are finding them out.

On our way back to town, I took the opportunity of asking him for his opinion on some points. His first observation was certainly flattering to "old J. B.," whom Brother Jonathan sometimes says he will "bust up." "Now, Mr. Edison, after what you have seen yesterday and to-day, how do you think we are getting on in this old country?" "You may be slow to begin," replied Mr. Edison, "but"—and here he nodded once or twice—"I must say that when you do go ahead, you may even beat us."

It is useless to disguise the fact that Mr. Edison's views on electric lighting are not in all respects in accord with those which have been practically adopted by the London Supply Corporation—in other words, by their accomplished engineer, Mr. Ferranti. Mr. Edison's own system of lighting in America is the low-pressure system; the London Com-

pany's is the high-pressure; Mr. Edison's is the system of direct current, the London Company's is the alternating current. "Our New York low-tension wires," said Mr. Edison, "are so absolutely safe that even a child may play with them." Then he spoke of the risks of "an enormous pressure through a narrow wire." In the London Company's system the wire is replaced by a hollow tube. But I must carefully guard the reader against supposing that Mr. Edison thinks the "London" Company's method "won't do." It is a question of how to obviate the risks, the existence of which Mr. Ferranti himself fully admits. And Mr. Edison himself, when summing up his impressions, exclaimed in his hearty way, "Oh, it will go." "In American towns," said Mr. Edison, replying to another question of mine, "we have a number of small stations instead of one or two huge ones, like the one at Deptford. A very high tension necessitates the use of a large single central station."

I then asked Mr. Edison about the relative progress of electric lighting in Paris, Berlin, New York, London. He considered Berlin to be the best lighted town (electrically) on the Continent. "Why," said Mr. Edison, "there is in Berlin a central station just half the size of the building at Deptford, with engines as powerful as those which we have just seen. In New York, as I have already told you, we have small stations, with capacity for a certain limited area, and within that area a householder who wants electric lighting has little more to do than to dig a narrow trench from his door to the street. We find that the low-tension system, besides being absolutely safe, under any circumstances, from risk of injury to the person, is safe in point of durability; I am thinking of one installation which has gone on uninterruptedly for seven years."

"The next thing you will have to do," said Mr. Edison, "will be to turn your electric force into motive power. Ah," said Mr. Edison, with a smile, "America is the country for that; in New York and other places, even small shopkeepers use electricity in scores of ways, in place of hand labour and old-fashioned mechanical appliances; they can buy it cheap—for a few cents for that matter. Electricity is not used as it should be, for lifts as an instance, in this country." Mr. Edison then passed on to the subject of traction. There, poor old England is nowhere. "Take electric railroads," said Mr. Edison; "every small town in the United States is supplied with them—the small towns even more liberally than the great cities; we have thousands of miles of electric railroad, and the motive force is supplied by overhead wires; and we find it cheaper and better in every way than car traction by horses, whose working lives last only four years." "Anyhow," I said, "London is about to make a move with that kind of thing also, or rather with something better; have you heard, Mr. Edison, of the underground railway—from the Monument to the Elephant and Castle—through which trains will be driven by electricity?" Mr. Edison shook his head. Then Sir John Pender bore testimony to the fact of this new enterprise. But Mr. Edison shook his head. Mr. Edison had not even heard of this project of Fish-street-hill and the Elephant and Castle. A one-horse affair like the Elephant and Castle's—why should tidings thereof raise an eyebrow in that wonderful continent where men plan how to grind electricity out of the cataracts of Niagara?

What did surprise Mr. Edison was the obvious fact that the Metropolitan and District Railway trains were not driven by electricity. "Nothing would be simpler," said Mr. Edison, "than to substitute electricity for steam." He had offered to do it long ago. If he got the order now he could carry it out almost offhand. And he gave a glowing picture of what the "Underground" would be without its steam and its vile choking sulphur fumes. On saying good-bye to Mr. Edison, I expressed the hope that he might make another effort to wake the London railway people up. To-day he leaves London for Paris, soon to return to New York, where he has yet to complete his great task of lighting the greatest city in the United States. It is worth going a long way for a hand-shake and a short talk with Mr. Edison. The greatest practical electrician who has ever lived is not more interesting than the man himself. We can realise

from the strong, resolute look how the poor boy whose regular schooling scarcely extended to a twelve-month succeeded in educating himself, by stray reading at a railway newspaper stall and haphazard studies in telegraphy at the railway signalling station. With all its strength, Mr. Edison's face wears a gentle expression. The expression of strength comes out when he is deeply interested in a discussion and driving his argument home. A noteworthy characteristic of the face is the singularly attractive smile and the mixture of shrewdness and kindness in the grey eyes, which, by the way, are not large. There is no simpler, more open, more unaffected man than Mr. Edison living. He seems as if he had no notion that he was anybody or anything in particular. His shrewd, ready common-sense comes out even in the smallest things. A gentleman of the party was remarking that if "once" a breakdown happened public confidence in the new light would vanish. "Twice," said Mr. Edison, on the instant, with his quiet smile; "the first time the public will excuse you, they will make allowance for inexperience; but if you do it a second time you are done for."

NOTES ON TRANSFORMERS.

BY CHARLES STEINMETZ.

A. When an alternating current is sent into the primary coil of a transformer, and its difference of potential at the primary terminals is kept constant, we have the following facts:

1. The E.M.F. in the secondary coil will be very nearly, though not absolutely, constant, no matter how the resistance of the secondary circuit be altered.

This E.M.F. E_1 is approximately given by the equation

$$E_1 = \frac{n_1}{n} E,$$

where E is the difference of potential at the primary terminals, n and n_1 the number of turns of primary and secondary coils respectively.

2. When the resistance of the secondary circuit is increased or diminished, the pressure at the secondary terminals also increases or diminishes, though very slowly.

3. The efficiency of the transformer—that is, the energy disposable in the secondary circuit—decreases in proportion with the increasing resistance of the same.

4. The lost effect of the transformer decreases with the increasing resistance of the secondary circuit; it reaches a minimum when the resistance has become infinitely great $= \infty$ —that is, when it is open.

Then the effect of the primary circuit is become approximately equal to zero.

B. When a current of constant intensity is sent into the primary coil of a transformer, we have the following facts:

1. The current intensity in the secondary coil remains approximately constant, whatever the secondary resistance, provided the latter is not too great.

This intensity, C_1 , is approximately represented by the equation

$$C_1 = \frac{n}{n_1} C,$$

where C stands for the intensity of the primary current, and n and n_1 are as before the number of turns of primary and secondary.

2. When the resistance of the secondary circuit reaches a certain critical point, the current intensity begins to decrease with the increasing resistance, first slowly, then faster, and being equal to zero when the resistance becomes infinitely great.

3. The efficiency increases with the increasing resistance of the secondary circuit, reaching a maximum behind the critical point of resistance, from whence it commences to decrease again.

4. The lost effect in the transformer is constant.

We see, therefore, that a transformer, when fed with a constant primary current, must be cut out as soon as the

resistance of the secondary circuit has passed the critical point.

On the other hand, a transformer having a constant primary potential may also be left in the circuit when not in use.

C. The same efficiency of the transformer may be reached by increasing the number of the alternations of the current x times, at the same time decreasing the turns $\sqrt{x}$ times. For instance, if the current have four times as many alternations as before, we shall only need half as many turns, found by dividing their original number by $\sqrt{4}$, which is 2.

This last rule, though not absolutely correct, will be found of great advantage in many practical cases.—*Electrical World*.

POST OFFICE TELEPHONE WIRES.

The following important order has been issued by the Postmaster-General:

"On and after the 1st October the telephone wires which have been provided by the Post Office between the following towns in South Wales may be used by the public on payment of a fee of 6d. for a conversation not exceeding three minutes:

Cardiff,	Pontypool,
Barry Dock,	Talywain,
Newport,	Briton Ferry,
Alexandra Dock,	Swansea.

Any person joining the telephone exchange of the department in one of these towns can use the wires to the other towns from his own office. Other persons can do so on going to an office of the department where a silence-box has been provided. For instance, such a person in Newport desiring to communicate with a firm in Cardiff, whose office is connected with the postal telephone exchange in that town, would go the head post office in Newport, where, on payment of the prescribed fee, he would be placed in telephonic communication with the office of his correspondent; or, if his correspondent's office was not so connected, he could direct him to attend at one of the post office silence-boxes in Cardiff punctually at a particular time, and there carry on the conversation.

The local telephone wires in the above-mentioned towns may also be used by the public; the fee for a conversation of not more than three minutes within one and the same town being 3d. Under this arrangement a person whose office is not connected with the local telephone exchange can at any time hold telephonic communication with a person whose office is so connected, on going to one of the offices of the department where a silence-box has been provided for the purpose.

The limit of three minutes may be exceeded on payment of 6d. or 3d., as the case may be, for each additional period of three minutes or less."

ADDRESS TO THE MECHANICAL SCIENCE SECTION OF THE BRITISH ASSOCIATION.

BY WILLIAM ANDERSON, M.I.C.E., PRESIDENT OF THE SECTION.

I have had considerable difficulty in selecting a subject which should form the main feature of my address. This meeting being held in Newcastle, it seemed almost imperative that I should dwell upon two industries which may be said to have had their genesis here; that I should direct your attention to the extraordinary development of the system of transmitting power by hydraulic agency, and the use of the same agency for lifting enormous weights or exerting mighty pressures; and that I should not neglect to notice a manufacture of specially national importance—that of heavy artillery and of ships of war sent forth fully equipped and ready to take their places in our first line of defence.

The desire which I felt of treating of these subjects was heightened by the opportunity which it would have afforded of paying a tribute of respect and admiration to the distinguished citizen of this town who, by his genius and perseverance, created the Elswick Works, raised the character of British engineering, and rendered his country services so eminent that Her Majesty

has seen fit to recognise them by bestowing honours higher than any which an engineer has hitherto been able to achieve.

But I felt that the themes mentioned, important as they are, have been frequently treated of by able men, and that I would perhaps render more service to mechanical science if I drew your attention to a subject which appears to me to be bearing with daily augmenting force on the practical manipulation of the materials used in construction. I allude to the molecular structure of matter. This branch of science has, up to the present time, been left very much in the hands of the chemist and the physicist, and I daresay that many engineers may think that it is by no means desirable to change the arrangement; but I am persuaded that the progress of engineering, the more exact methods of dealing with the properties of materials, the increased demands on their powers of endurance, render it imperatively necessary that mechanics should interest themselves more deeply in their internal structures and in the true meaning of the laws by which their properties are defined.

Five years ago, at Montreal, in his address to the mathematical section, Sir William Thomson took for his subject the ultimate constitution of matter, and discussed, in a most suggestive manner, the very structure of the ultimate atoms of molecules. He passed in review the theories extant on the subject, and pointed out the progress which had been made in recent years by the labours of Clausius, of Clerk Maxwell, of Tait, and of others, among whom his own name, I may add, stands in unrivalled prominence.

I will not presume to enter into the field of scientific thought and speculation traversed by Sir William Thomson, because I am only too conscious that both my mathematical knowledge and my acquaintance with the natural sciences is too limited to entitle the views which I may have formed to any respect; I propose to draw attention only to some general considerations, and to point out to what extent they practically interest the members of this section.

In a lecture delivered at the Royal Institution last May, Prof. Mendeleeff attempted to show that there existed an analogy between the constitution of the stellar universe and that of matter as we know it on the surface of the earth, and that from the motions of the heavenly bodies down to the minutest interatomic movements in chemical reactions the third law of Newton held good, and that the application of that law afforded a means of explaining those chemical substitutions and isomerisms which are so characteristic, especially of organic chemistry.

Examined from a sufficient distance, the planetary system would appear as a concrete whole, endowed with invisible internal motions, travelling to a distant goal. Taken in detail, each member of the system may be involved in movements connected with its satellites, and again each planet and satellite is instinct with motions which, there is good reason to believe, extend to the ultimate atoms, and may even exist, as Sir W. Thomson has suggested, in the atoms themselves. The total result is complete equilibrium, and, in many cases, a seeming absence of all motion, which is in reality the consequence of dynamic equilibrium, and not the repose of immobility or inertness.

The movements of the members of the stellar universe are, many of them, visible to the eye, and their existence needs no demonstration; but the extension of the generalisation just mentioned to substances lying, to all appearances, inert on the earth's surface is not so apparent. In the case of gases, indeed, it is almost self-evident that they are composed of particles so minute as to be invisible, in a condition of great individual freedom. The rapid penetration of odours to great distances, the ready absorption of vapour and of other gases, and the phenomena connected with diffusion, compression, and expansion seem to demonstrate this. One gas will rapidly penetrate another and blend evenly with it, even if the specific gravities be very different. The particles of gases are, as compared with their own diameters, separated widely from each other; there is plenty of room for additional particles; hence any gas which would, by virtue of its molecular motion, soon diffuse itself uniformly through a vacuum will also diffuse itself through one or more other gases, and once so diffused, it will never separate again. A notable example of this is the permanence of the constitution of the atmosphere, which is a mere mixture of gases. The oxygen and the nitrogen, as determined by the examination of samples collected all over the world, maintain sensibly the same relative proportions, and even the carbonic acid, though liable to slight local accumulations, preserves, on the whole, a constant ratio, and yet the densities of these gases differ very greatly.

Liquids, though to a much less degree than gases, are also composed of particles separated to a considerable relative distance from each other, and capable of unlimited motion where no opposing force, such as gravity, interferes; for under such circumstances their energy of motion is not sufficient to overcome the downward attraction of the earth; hence they are constrained to maintain a level surface.

The occlusion of gases without sensible comparative increase of volume shows that the component particles are widely

separated. Water, for example, at the freezing-point occludes above one and three-quarter times its own volume of carbonic oxide, and about 480 times its volume of hydrochloric acid, with an increase of volume, in the latter case, of only one-third, and sulphuric acid absorbs as much as 600 times its bulk of methylic ether. The quantity of gas occluded increases directly as the pressure, which seems to indicate that the particles of the occluded gas are as free in their movements among the particles of the liquid as they would be in an otherwise empty containing vessel.

Liquids, therefore, are porous bodies whose constituent particles have great freedom of motion. It is no wonder, consequently, that two dissimilar liquids, placed in contact with each other, should interpenetrate one another completely, if time enough be allowed; and this time, as might be expected, is considerably greater than that required for the blending of gases, because of the vastly greater mobility of the particles of the latter. The diffusion of liquids takes place not only when they are in actual contact, but even when they are separated by partitions of a porous nature, such as plaster of Paris, unglazed earthenware, vegetable or animal membranes, and colloidal substances, all of which may be perfectly watertight in the ordinary sense of the term, but yet powerless to prevent the particles of liquids making their way through simultaneously in both directions.

The rate of diffusion increases with the temperature, but an increase of temperature, we know, is synonymous with increased molecular motion of the body, and with increased activity of this kind we would naturally look for more rapid interchanges of the moving atoms. Such phenomena are only conceivable on the supposition that active molecular motion is going on in an apparently still and inert mass.

When we come to solid substances the same phenomena appear.

The volumes of solids do not differ greatly from the volumes of the liquids from which they are congealed, and the solid volumes are generally greater. The volume of ice, for example, is one-tenth greater than that of the water from which it separates. Solid cast iron just floats on liquid iron, and most metals behave in the same way, consequently, if the liquids be porous, the solids formed from them must be so also; hence, as might be expected, solids also occlude gases in a remarkable manner. Platinum will take up five and a half times its own volume of hydrogen, palladium nearly 700 times, copper 60 per cent., gold 29 per cent., silver 21 per cent. of hydrogen and 75 per cent. of oxygen, iron from eight to twelve and a half times its volume of a gaseous mixture, chiefly composed of carbonic oxide.

Not only are gases occluded, but they are also transpired under favourable conditions of temperature and pressure, and even liquids can make their way through. Red-hot iron tubes will permit the passage of gases through their substance with great readiness. Mr. Goodman stated, during a recent discussion at the Institution of Civil Engineers, that petroleum passed through a red-hot boiler-plate half an inch thick, and it is well known that mercury will penetrate tin and other metals with great rapidity, completely altering their structure, their properties, and even their chemical compositions.

The evidence of the mobility of the atoms or molecules of solid bodies is overwhelming. Substances when reduced to powder may, even at ordinary temperatures, be restored to the homogeneous solid condition by pressure only. Thus, Prof. W. Spring, some 10 years ago, produced from the powdered nitrates of potassium and sodium, under a pressure of 13 tons to the square inch, homogeneous transparent masses of slightly greater specific gravity than the original crystals, but not otherwise to be distinguished from them. More than that, from a mixture of copper filings and sulphur he produced, under a pressure of 34 tons per square inch, perfectly homogeneous cupreous sulphide, Cu_2S , the atoms of the two elements, having been brought, by pressure, into so intimate a relation to each other, that they were able to arrange themselves into molecules of definite proportion; and, still more remarkable, the carefully-dried powders of potash, saltpetre, and acetate of soda were, by pressure, caused to exchange their metallic bases and form nitrate of soda and acetate of potash.

The same movements and changes have taken place, and are still going on, in nature's laboratory. During the countless ages with which geology deals, and under the enormous pressures of superincumbent masses, stratified sedimentary rocks become crystallised and assume the appearance of rocks of igneous origin, and not only so, but rocks of whatever origin, crushed and ground to pieces by irresistible and geological disturbances, reconstruct themselves into new forms by virtue of the still more irresistible and constant action of molecular forces and movements. Those who had the privilege of hearing Prof. A. Geikie's brilliant lecture at the Royal Institution last session will remember the striking series of microscopic slides which he exhibited, and by the aid of which he illustrated the changes of structure to which I have alluded.

At high temperatures the same effects are more easily produced on account of the greater energy of motion of the atoms

or molecules. In the process of the manufacture of steel by cementation, or in case-hardening, the mere contact of iron with solid substances rich in carbon is sufficient to permit the latter to work its way into the heart of the former, while in the formation of malleable cast iron the carbon makes its way out of the castings with equal facility, it is a complete case of diffusion of solid substances through each other, but on account of the inferior and restricted mobility of the particles at ordinary temperatures a higher degree of heat and longer time are needed than with liquids or gases.

Again, when, by the agency of heat, molecular motion is raised to a pitch at which incipient fluidity is obtained, the particles of two pieces brought into contact will interpenetrate or diffuse into each other, the two pieces will unite into a homogeneous whole, and we can thus grasp the full meaning of the operation known as "welding." By the ordinary coarse methods but few substances unite in this way, because the nature of the operation prevents, or at any rate hinders, the actual contact of the two substances; but when molecular motion is excited to the proper degree by a current of electricity, the faces to be joined can be brought into actual contact, the presence of foreign substances can be excluded, and many metals not hitherto considered weldable, such as tool steel, copper, and aluminium, are readily welded, as many of us witnessed at the hands of Prof. Ayrton in the highly instructive lecture on electricity delivered last year at our meeting at Bath.

Again, a mere superficial union of different metals takes place readily under the influence of high temperature and moderate pressure, as we see in the operations of tinning, soldering, and brazing. The surfaces of the metals must be made as clean as possible; the solder, which melts at a lower temperature than the metal to be soldered or brazed, is applied, and at a comparatively moderate temperature and under very slight pressure the particles interpenetrate each other; the two metals unite and form an alloy, by the intervention of which the two surfaces are joined. This effect is very well illustrated by the action which takes place at the surface of contact of two dissimilar liquids. If brine, for example, be placed in the lower part of a glass tube, and ordinary water, coloured in some way, be carefully poured on the top, a sharp plane of demarcation will appear, but in a short time the plane of separation will become blurred, and will ultimately disappear, a local blending of the two waters will take place, and will thus present a case of fluid welding.

It seems plain, therefore, that apparently inert solid masses are also built up of moving particles in dynamic equilibrium, for without such an assumption it would be hard to explain the phenomena to which I have alluded. But in addition to this evidence, we can adduce the effects of other forms of energy, which we recognise under the names of radiant heat, light, and electricity. These we know to be forms of motion which can be communicated and converted from one to the other, from the invisible to the visible. The movement which we term radiant heat, acting through the instrumentality of the luminiferous ether which is believed, on the strongest grounds, to pervade all space and all matter, is competent to augment the quantity of movement in the particles of substances, and generally to cause an enlargement of volume; and conversely, when the particles, by contact or radiation, part with their heat, either to surrounding objects or to space, the quantity of motion is reduced, the body contracts, and this contraction goes on down to temperatures far below those at which we have to work in practice, and, consequently, at all ordinary temperatures there must be abundant room for molecular motion.

Again, energy in the form of light operates changes in the surface of bodies, causing colours to fade, and giving to photography the marvellous power which it possesses; decomposing the carbonic acid of the atmosphere in the chlorophyll of green leaves, and determining chemical combinations, such as chlorine with hydrogen to form hydrochloric acid, or carbonic oxide with chlorine to form chlorocarbonic acid. It is inconceivable that these effects could be produced unless the undulations of light were competent to modify the molecular motions already existing in the solid, liquid, and gaseous bodies affected.

Electricity exerts a similar influence. Generated by the molecular movements caused by chemical activity, whether directly, as in the primary battery, or indirectly, as in the dynamo, it is competent to increase the molecular movements in bodies so as to produce the effects of heat directly applied; it is capable of setting up motions of such intensity as to produce chemical changes and decompositions, to say nothing of the whole series of phenomena connected with magnetism, with induction, or the action through space and through non-conducting bodies, which, as in the case of radiant heat and light, seems to imply the existence of an interatomic ether. Conversely, changes of molecular equilibrium, brought about by the action of external forces, produce corresponding changes in electrical currents: witness the effects of heat, for example, on conductivity and the wondrous revelations of molecular change obtained by the aid of Prof. Hughes's

induction balance. The behaviour of explosives illustrates also, and in a striking manner, the effects of disturbing molecular equilibrium. An explosive is a substance which contains in itself, in a solid or liquid form, all the elements necessary to produce a chemical change by which it is converted into the gaseous state. The application of heat, of pressure, or of impact, causes, as in Prof. Spring's experiments, chemical union to take place, first at the spot where the equilibrium is disturbed by the application of external force, and afterwards with great rapidity, throughout the mass, the disturbance being propagated either by the air surrounding the particles or by the luminiferous ether, with all the rapidity of light; the chemical reaction is accelerated by the pressure which may arise, for example, if the explosive be confined in the chamber of a gun, or in the bore-hole of a blast. High explosives, as they are termed, are comparatively inert to ordinary ignition; but when the molecular equilibrium is suddenly disarranged throughout the mass by the detonation of a percussion fuse, combination takes place instantly throughout, and violent explosion follows. In a similar manner some gases, such as acetylene, cyanogen, and others, can be decomposed by detonation and reduced to their solid constituents. Prof. Thorpe has devised a very beautiful lecture experiment, in which carbon disulphide is caused to fall asunder into carbon and sulphur by the detonation of fulminate of mercury fired by an electric spark. In these cases a reverse action takes place, but illustrates equally well the conversion of one form of energy into others, and the consequent disturbance of molecular equilibrium in the substances affected. It seems to me clear, therefore that the time has come when the conception of dynamic equilibrium in the ultimate particles of matter in all its forms must take the place of the structural system of inert particles. I cannot conceive how the phenomena which I have enumerated can be explained on the supposition that matter is built up of motionless particles—how, for example, a stack of red and yellow bricks could ever change the order of arrangement without being completely pulled asunder and built up again, in which case an intermediate state of chaos would exist; but I can easily comprehend how a dense crowd of people may appear as a compact mass, streaming, it may be, in a definite direction, and yet how each member of that mass is endowed with limited motion, by virtue of which he may push his way through without disturbing the general appearance; how the junction of two crowds would form one whole, though, perchance, altered in character, and how even Prof. Spring's experiments may be explained by the supposition that bystanders on the edge of a crowd would be forced, by external pressure, to form part of it and partake of its general movements.

It is a suggested fact that the product of the atomic weight of certain groups of substances and their specific heats is a constant quantity which, for the greater number of the elements, does not differ much from 6.5. This implies that the quantity of heat necessary to raise the temperature of the atoms of any one of the groups to any given extent is the same; hence these atoms will be endowed with the same amount of energy at any given temperature, and therefore would be competent to replace each other without disturbing the general dynamic equilibrium.

When it is conceded that molecular action pervades matter in all its forms, and that the solid passes, often insensibly, into the fluid, or even direct into the gaseous, it follows, almost of necessity, that there must be a borderland, the limits of which are determined by temperature and pressure, in which substances are constantly changing from one state to another. This is observable in fusion, but to a more marked degree in evaporation, where the particles are being incessantly launched into space as gas and return as constantly to the liquid state. Henri St. Claire Deville has investigated similar phenomena in chemical reactions; he has found that at certain temperatures and pressures substances fall asunder and combine much in the way in which evaporation takes place, and has given the name of "dissociation" to this property of matter. Prof. Mendeleeff and others have extended the great French chemist's observations, and have formulated the general law that substances are capable of dissociation at all temperatures, not only in the case of chemical unions, but also in that of solutions.

If steel be looked upon as a solution of carbon and iron, then the hardening of steel is explained by the theory that dissociation has taken place at the temperature at which it is suddenly cooled, the sudden cooling fixing the molecular motion at such an amplitude or phase that it gives a characteristic structure, one of the properties of which is extreme hardness. In tempering, the gradual communication of heat causes dissociation again to take place, the molecular equilibrium is modified by the increased energy imparted to the particles, and when suddenly cooled at any point there remains again a distinct substance, composed of iron and carbon, partly in various degrees of solution and partly free, and again possessing special mechanical qualities. That steel, and probably other alloys, differ in the nature of their composition according to the way in which they are worked, both with respect to heat and mechanical pressure, has been abundantly proved by many eminent metallur-

gists, and especially by Sir Frederick Abel, in the extended researches which he has recently carried out on the hardening of steel, for the Institution of Mechanical Engineers, and it would appear as a natural sequence that the properties of steel would be greatly affected by the manner in which its temperature was changed, as we indeed find that it is when these changes are produced by baths of melted metals, by oil, or by water at different temperatures. The action which takes place may be illustrated by what would happen supposing that a complicated dance, such as the lancers, were suddenly stopped in various phases of the figures. The component parts would always remain the same, but the relative distribution of the partners would vary continually, and analysis would show that at one time each gentleman was associated with a particular lady; at another, that two ladies were attached to a single gentleman, while a number of gentlemen had no partners at all; and yet again, at another, that the movements which were once rectilinear have become circular. In each case the groups would assume a totally distinct appearance.

In support of these views it may be stated that, as far as I know, no pure element is capable of being hardened or tempered, the reason being that no chemical change can take place when there is only one substance. The effect of heat or pressure, however suddenly applied, produces merely a change of form which does not appear to carry with it any corresponding alteration of mechanical properties.

It may be urged, however, that it is unlikely that alloys or solutions could be affected in a manner so marked merely by small changes at comparatively low temperatures; but I would observe that "great" and "little" are relative terms, and we have abundant evidence of the immense effects produced by what would be called "little" causes. Sir Frederick Bramwell, in his address last year, drew attention to the importance of the "next to nothing." It is not so very long ago that anyone would have been considered a dreamer for propounding a theory that the presence of the fraction of a per cent. of carbon, phosphorus, or sulphur would totally alter the character of iron; that the addition of one two-thousandth part of aluminium to molten iron would make the pasty mass as fluid as water; that the presence of the smallest impurity in copper would have a disastrous effect on its powers of conducting electricity; and that the addition of one-thousandth part of antimony would convert the "best selected" copper into the worst conceivable. I need hardly allude to the great part played in nature by microscopic organisms, and how much of the beauty of our seas and rivers is derived from substances so minute that nothing but the electric beam of Prof. Tyndall is capable of revealing their presence.

There is one more circumstance connected with my subject to which I must draw your attention, because, though its application to the mechanical properties of substances is very recent, it promises to be of great importance. I allude to the periodic law of Dr. Mendeleeff. According to that law, the elements, arranged in order of their atomic weights, exhibit an evident periodicity of properties, and as Prof. Carnelley has observed, the properties of the compounds of the elements are a periodic function of the atomic weights of their constituent elements. Acting on these views, Prof. Roberts Austin has recently devoted much time and labour to testing their exactness with reference to the mechanical properties of metals. The investigation is surrounded by extraordinary difficulties, because one of the essential features of the enquiry is that the metals operated on should be absolutely pure. For chemical researches, a few grains of a substance are all that is needed, and the requisite purity can be obtained at a moderate cost of time and labour; but when mechanical properties have to be determined considerable masses are needed, and the funds necessary for obtaining these are beyond the reach of most private individuals. I cannot help suggesting that wealthy institutions, such as many of those connected with our profession, could not employ their resources more wisely than in giving the means of following up the researches which Prof. Roberts Austin has inaugurated.

In view of the difficulty of obtaining metals of sufficient purity, he selected gold as his base, because that metal can be more readily brought to a state of purity than any other, and is not liable to oxidation. In a communication to the Royal Society, made last year, he shows that the metals alloyed with gold which diminish its tenacity and extensibility have high atomic volumes, while those which increase these properties have either the same atomic volumes as gold or have lower ones. The enquiry has only just been commenced, but it appears to me to promise results which, to the engineer, will prove as important and as fruitful of progress as the great generalisation of Mendeleeff has been to chemists. A law which can not only indicate the existence of unknown elements, but which can also define their properties before they are discovered, if capable of application to metallurgy, must surely yield most valuable results, and will make the compounding of alloys a scientific process instead of the lawless and haphazard operation which it is now.

(To be continued.)

THE PASSAGE OF ELECTRICITY THROUGH GASES.*

BY ARTHUR SCHUSTER.

The author has, during the last two years, investigated the distribution of potential in the neighbourhood of the negative pole of discharge of electricity through rarefied gases. Knowing the rate of fall of potential, it can be determined whether there is any bodily electrification in any part of the negative glow. It was found that the cathode is surrounded by an atmosphere of positively-electrified gaseous particles extending to the outer edge of the so-called dark space. According to the author's views, this atmosphere corresponds to the polarised layer adjoining the negative electrode in an electrolyte. The cause of the sudden difference in luminosity between the dark space and the negative glow has also been investigated, and it has been found that the negative particles projected from the cathode pass unhindered through the dark space, while their velocity is quickly reduced in the glow proper, the translatory energy being thus changed into energy of vibration.

ELECTRIC LAUNCHES ON THE THAMES.*

BY PROF. G. FORBES.

This paper on Electric Launches on the Thames has arisen out of the fact that during the past summer, while I was living down the river at Bray, I was enabled to have the opportunity of keeping one of those electric launches, which have been built by Messrs. Tagg lately, and electrically equipped by Messrs. Immisch. I thought it would be interesting to draw attention to one's experiences in this connection. I speak not only from my own observations, but from those of everyone who has used them on the river, and also the views of a very large number of those who have seen the performances of these boats and watched them, and who are habituated to the river, when I say that there is hardly the slightest doubt that in the course of a very few years the steam launch as a pleasure boat on the River Thames will be entirely abolished.

On the River Thames there are some special peculiarities which make the electric launch peculiarly suitable, and it by no means follows from what I have said that in other cases the electric launch will be as speedily and universally adopted. Among the points worthy of notice are—in the first place, that launches on the river are required chiefly in summer, when the heat, smoke, smell, oil, and dirt of a steam launch are objectionable; and also that, owing to the larger traffic, and to prevent injury to banks and boats which are tied to the banks on the river, it is impossible on the Thames to allow high speeds in launches. Hence a comparatively small supply of storage batteries or accumulators is required for driving the electric launches at the very moderate speeds which are permissible on the River Thames.

It may be also added that on the Thames it is easy to secure a sufficient number of charging stations. At present there are four or five at easy distances apart. Eventually there can be little doubt that the hotels on the river will find it financially a good plan to be lighted electrically, and then this power which they have on the premises can be used during the night for charging the storage batteries of launches.

The house which I occupied was at Bray, just below Maidenhead, and each night I took the launch by myself, towing a boat behind, up to the charging station (which was not a mile away). I left it there to be charged during the night, and by breakfast time the launch was outside ready charged, with a sufficient supply to last me the whole day. I may mention that I never exhausted the complete charge of the batteries in my launch during the whole time. I generally went out shortly after breakfast, spent the whole day on the river, very often coming home at eight o'clock, and afterwards taking it up to the charging station in the evening; and certainly 40 miles was not by any means enough to exhaust the supply of electricity on the launch.

The management of the boat is extremely easy, the steering gear and everything about it being perfectly handy. There was no difficulty in crowded locks going in and bringing up alongside of a lock with the greatest ease.

This launch, which was called the "Delta," is 33ft. in length, has a beam of 6ft., the draught is 15in. forward and 18in. at the stern. She is fitted with 44 cells, weighing in all 2,520lb. She is steered by a wheel in front within reach of the three handles which are required for working her. The first of these handles is used for putting the current on or off, the second one for putting it to half-speed or full-speed, and the third for going ahead or astern. The first one is mechanically moved with the others, so that they cannot be moved without first cutting off the current. Fusible cut-outs are inserted in the circuit, so that if the propeller becomes jammed by weeds or by going aground the motor will not burn up. The speed of revolution of the motor, which is coupled direct to the propeller, is 720 revolutions per minute for full speed, and 510 revolutions for half-speed. The speed is only between five and six miles an hour for full speed. This is, perhaps, the weak point of this launch. I must say there are times when you are going against a strong current in some parts of the stream where a greater speed would be desirable, and it becomes a little tedious creeping up. It is only in a strong stream that one really finds it a little too slow, and for all ordinary purposes it is quite enough. However, the speed might be very advantageously increased a little, I think, by putting in more accumulators, which the launch could easily carry under the floor without overloading. At present the batteries are all under the seats on each side of the boat, and thus the whole of the space in the boat is clear for passengers. My launch could easily have carried twenty

* Papers read before the British Association at Newcastle-on-Tyne.

with perfect comfort. It is here that the electric launch has a very great advantage over the steam launch; if we consider the size of the launch, and the number of passengers it will hold, the electric launch is really the cheaper of the two.

I spent a day in making tests of the performance of the launch, which may be of a little interest, though they do not go very far. I started from my house one morning at 11.45. I made allowance as I went through the locks for the time that was taken in going through locks and so on, and for other stoppages, and timed everything during the whole way. At one minute past four I was near Hambleton Lock, and began the return journey. Stopping an hour at Medmenham Abbey, I reached Bray again at 7.48 p.m. During all this time the exact measurements of the time were taken, and the result was that in the outward journey up stream the average speed was one mile in 11.3 minutes, and on coming down stream the average speed was one mile in 10.2 minutes. The average of these two is 790 ft. per minute. On arrival at home the stern was attached to a spring balance connected by a rod with the shore. The pull at full speed was then measured, and found to be 97 lb., which, although it does not accurately represent the pull when the launch is in movement, still it does so with considerably close approximation. This gives us 1.44 h.p., or 1,074 watts, including electrical losses, slip, and all friction. The pressure of 97 lb., over 790 ft. per minute, gives that result. The average pressure at the motor terminals during the run was 78 volts, and the average current was 23 amperes, which gives 1,794 watts expenditure.* This gives a total efficiency, including all these losses of slip, friction, and the end thrust of the propeller, and the electrical losses in the motor, at 60 per cent., which seems to me an extremely fair performance in one of the first types of electric launches which have been constructed by these makers.

I would suggest that there is a very large field open in future—if somebody could be got to organise it, for the delight of those who wish to use these extremely convenient launches on the river—namely, that, in order to supply the enormous demand which will certainly exist after a few years for charging stations, negotiations should be opened by somebody who has the energy to do so with the Thames Conservancy and also with the mill owners—which exist at nearly all the weirs—so as to establish charging stations with water power at nearly everyone of the weirs on the part which launches frequent, and thus to establish what would undoubtedly be a most perfect method of launching in any part of the world.

ON HYSTERESIS IN THE RELATION OF STRAIN TO STRESS.*

BY PROF. J. A. EWING, F.R.S.

It is now well known that when an iron wire is subjected to the alternate application and removal of tensile stress, many times repeated, certain of its qualities which are affected by the changes of stress exhibit hysteresis with regard to the changes of stress. If the load is cyclically varied between definite limits these qualities do not have the same values at corresponding intermediate points during the application and removal of load; there is a hysteresis or lagging in the change of quality which in some cases appear to be of a static character—that is to say, independent of the time-rate of variation of stress. Conspicuous instances of this action are seen in the change of magnet and thermo-electric qualities under change of stress, some of which have been described by the author in former papers.

It is natural to look for an effect of the same kind in the extension and retraction which the wire undergoes. We should expect that, after the change of loads has been frequently repeated, so that a cyclic régime is established, the wire will, for any value of load intermediate between the two extremes, be longer during unloading than during loading. Evidently, if such an effect exist, it must be small, as it is well known that the proportionality of strain to stress which is expressed by Hooke's law is at least approximately exact. Sir W. Thomson's experiments on the damping of torsional vibrators have long ago shown that an action of the kind spoken of occurs in quickly-performed cycles of torsional strain; but it does not seem to have been looked for in slow cycles of longitudinal pull.

The author has, with the assistance of one of his students, Mr. D. Low, looked for the effect in question, and has found it, not only in iron, but in steel, brass, and copper wires. He has not yet examined other metals.

The experiment consisted in observing, with much optical magnification, the extension of a very long piece of wire, directly loaded with lead weights. The wire was hung from a rigid support in a testing flue or recess, built in the wall of the laboratory, and extending up through four storeys. At a distance of 306 centimetres below the top, a small clamp was fixed on the wire, and this formed the support of the back foot of a little tripod, the feet of which consisted of three needle points about an inch apart. The two front feet rested in a slot and hole in a fixed shelf, which stood in front of the long wire. The tripod carried a plane mirror which became tilted forward or backward as the wire extended or retracted. Readings were taken by a telescope of the reflected scale of a levelling staff placed vertically at a distance of some five metres from the mirror. The staff was graduated to $\frac{1}{100}$ th of a foot, and it was easy to read by estimation to $\frac{1}{1000}$ th of a foot, which corresponded to 0.00000102 of the length of the wire. At first a fixed shelf was used to support the two front feet of the mirror, but the effects of temperature were found to be excessive, although the greatest care was taken to shield the wire from draughts, and the plan was resorted to of hanging the shelf from two adjacent wires of the same material, suspended from the same support as the wire which was to be stretched. In this form the method of optical multiplica-

tion was nearly the same as one used by Mr. Bottomley in recent experiments on the extension of loaded wires by heat.

The first wire tested was of iron, in the hard-drawn state, 1.08 millimetre in diameter. A weight of 14 lb. was kept permanently on it, and an additional weight of 20 kilometres was applied and removed many times. Then readings were taken at intermediate loads (the extreme load caused so much tilting of the mirror that readings could not be taken throughout the whole range). At 10 kilometres (the middle of the cycle) on the way up the scale reading was 2,340; with the same weight on the way down it was 2,305. The difference, due to hysteresis, is 35, or 0.0000357 of the length. The whole extension per kilometre was 533 scale divisions, so that the change of length due to the full load of 20 kilometres was $20 \times 533 = 10,660$ scale divisions. Hence the amount of difference in length at the middle position or, 10 kilometres, in the loading and unloading processes was $\frac{1}{150}$ th, or, say, $\frac{1}{150}$ th of the whole extension between the extreme load. Another way of stating the result would be to say that the extension had the same value at 10.066 while the load was being increased as it had at 10 kilometres while the load was being diminished; the effect of hysteresis is equivalent to a difference of 66 grammes in the load.

Further experiments were made to test how far this hysteresis depends on the time rate of loading and unloading. In the above case, the cycle of load had been performed as quickly as was practicable, the only pauses being at 10 kilometres on the way up and at 10 kilometres on the way down. It was found that even when the pause at 10 kilometres lasted for two hours no distinct change took place in the readings. So far as this experiment showed, the hysteresis is persistent. It appeared, however, that pauses at the extremes of load has the effect of increasing the difference of readings at the middle. In a slowly performed cycle, where a pause of about three minutes was allowed at each step (of two kilometres) in the processes of loading and unloading, the difference of the readings at 10 kilometres was about 50 scale divisions instead of the 35 divisions observed in the former case.

A similar trial was made with mild steel wire, previously annealed and then hardened by the imposition of a load much greater than the load afterwards used in the testing cycle. Here the wire was 0.94 millimetres in diameter. There was, as in a former case, a constant load of 14 lb., and the cycle was made by applying and removing 12 kilometres. At six kilometres the readings were 4,695 and 4,726; difference, 31. The extension per kilometre was 750. Hence the hysteresis is $\frac{31}{12 \times 750} = \frac{1}{290}$ of the extension due to the whole load.

With long pauses at the middle load the hysteresis appeared to be reduced to 27 scale divisions, or $\frac{1}{33}$ of the whole extension.

Next, a hard wire of high carbon steel was tested, 0.72 millimetres in diameter, by having 14 lb. permanently on, and loading and unloading 12 kilometres. At six kilometres the readings were: "Up" 9,220, creeping to 9,240 in two hours; "down" 9,400, creeping to 9,370 in two hours. Differences, 180 and 130.

The extension for one kilometre was 1,290, so that the above differences correspond to $\frac{1}{7}$ th and $\frac{1}{10}$ th of the whole extension respectively. It is remarkable that the hysteresis is decidedly greater here than in the wires previously tested.

A brass wire 1.03 millimetres in diameter tested in the same way with 12 kilometres gave readings 6,990 and 7,114 at six kilometres, difference = 124, which was equivalent to $\frac{1}{17}$ th of the whole extension, since the extension for one kilometre was 1,100 scale divisions.

With a copper wire 1.15 millimetre in diameter, loaded with 10 kilometres, the readings at five kilometres showed a difference of 52 scale divisions, equivalent to $\frac{1}{10}$ th of the whole extension.

These experiments make it clear that in conditions of loading such as those they deal with there is a decided departure from Hooke's law, one effect of which is that some work is done upon the material when it is put through a cycle of stress change. If the relation of strain to stress were represented graphically, the curves would form loops enclosing a certain area. This result has a sufficiently obvious bearing on the conclusions of Wöher with regard to the deteriorating effect of repeated variations of stress.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for the past week amounted to £3,170.

Reuter's Telegram Company, Limited.—An interim dividend has been declared by this Company at the rate of 5 per cent. per annum, tax free, for the half-year ending June 30, payable on 12th prox.

Western and Brazilian Telegraph Company, Limited.—The receipts for the week ended September 20, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,071.

Eastern Extension Telegraph Company, Limited.—This Company, for the half-year ended June 30, have declared a dividend for the quarter ended at that date of 2s. 6d. per share, payable, tax free, on the 15th prox., and have decided to charge £50,000 against revenue on account of the Western Australian cable, carrying £26,236 to the next account.

Direct Spanish Telegraph Company, Limited.—This Company in their report for the half-year ended the 30th June state that they have put £2,500 of the profit balance to the reserve fund, which now amounts to £14,837, and recommend a dividend at the rate of 10 per cent. on the preference and one at the rate of 5 per cent. per annum, tax free, on the ordinary shares, carrying forward £44. The dividend warrants will be issued on the 1st of October.

* Paper read before the British Association at Newcastle-on-Tyne.

COMPANIES' MEETINGS.

HALIFAX AND BERMUDA CABLE COMPANY, LIMITED.

The statutory general meeting of this Company was held on the 20th inst. at Winchester House, Old Broad-street.

Sir Alexander Armstrong, who presided, stated that the meeting had been called, in compliance with the Companies' Acts, within four months of the incorporation of the Company. They had concluded in a very satisfactory manner all their arrangements with the Government, from whom throughout the negotiations they had received very fair and equitable treatment. In future communications with the Government—and they would necessarily have to be many and frequent—they looked forward hopefully to receiving the same support as hitherto, which would tend largely to promote the efficiency of the service in which both the Government and the Company were so deeply interested. The cable work was now being proceeded with as rapidly as possible, and they anticipated its completion at an early period. The tests of the working of the cable had so far been very satisfactory. The Government had appointed the principal electrician of the Post Office to supervise the work, and the company's engineers were Messrs. Clark, Ford, and Taylor. He thought there was thus sufficient guarantee that everything possible would be done to obtain an excellent cable. They were now in communication with the Government with respect to the points where the ends of the cable should be landed, both at Halifax and Bermuda. It was necessary that the cable should be laid under the protection of the guns of the fortresses at both places, and that they should be put in communication with the Governor of Bermuda and the officers commanding the troops at Halifax. Until they knew the result of these communications they could not say exactly where the cable would be laid. The Government had in the Island of Bermuda an admirable system of telegraphy and there was a private firm of telephony. Thus communications throughout the island were assured, and the means of communication with the mainland were brought within the reach of everyone. They anticipated having a very extensive traffic from Bermuda, which on account of the climate was a very fine winter resort, though the island had hitherto suffered through the want of telegraphic communication with the mainland. From its strategical position also Bermuda was a place of importance; and, with the establishment of the Company's cable, the place would become a great port of call for steamers. Altogether he looked forward hopefully to their prospects after the cable was at work.

In answer to questions, the Chairman stated that about 200 knots of the cable were already made. He could not say exactly when it would be finished, but he hoped that it would certainly be completed before the end of the year. The payment of the Government subsidy would begin from their sending the first message through the cable. The debenture interest would be paid in the meantime. To a certain extent they were bound to complete the work in a specified time, but if they could not do so, he had no doubt they would receive the same consideration as hitherto from the Government. The contractors were bound to deliver the cable within a certain time, and the Directors entertained no doubt that that would be done. As he had said, they expected to have the cable shipped and laid before the end of the year. That would meet the Company's contract with the Government.

The proceedings then terminated.

PROVISIONAL PATENTS, 1889.

SEPTEMBER 16.

14551. **A primary battery solution.** Herbert Arthur Henderson, 17, St. Ann's-square, Manchester.
14552. **Improvements in or relating to primary batteries.** Herbert Arthur Henderson, 17, St. Ann's-square, Manchester.
14565. **Improvements in the method of and apparatus for recording telegraphic or other signs, more especially applicable to syphon recorder telegraphic instruments.** George Draper and William Henry Ash, 3, Elm-court, Temple. (Complete specification.)
14571. **Improvements in electrical switches.** Andreas Peter Lundberg, 18, Regina-road, Tollington-park, London.
14589. **Improvements in printing telegraphs.** Frederick Herbert William Higgins, 24, Southampton-buildings, London.
14590. **Improvements in electric bells.** Harrison Groves and Joseph Henry Stewart, 24, Southampton-buildings, London.

SEPTEMBER 17.

14593. **Improvements in metallic circuits or conductors of electrical energy.** Henry French Campbell, 55 and 56, Chancery-lane, London. (Complete specification.)
14601. **An improved connector for the elements of electric batteries.** George Macaulay-Cruikshank, 62, St. Vincent-street, Glasgow. (Sidney H. Barrett, Massachusetts.) (Complete specification.)
14636. **Improvements in apparatus for the automatic control and regulation of electrical currents for electric lighting and other purposes.** George Fletcher, 53, Sale-street, Derby.
14649. **An improved covering for steam-pipes, electric wires, and the like.** William Robert Lake, 45, Southampton-buildings, London. (Charles Tennant Lee, United States.) (Complete specification.)

14656. **Improvements in electric glow lamps.** Alexander Bernstein, 4, South-street, Finsbury, London.

14664. **Improvements in and relating to door-bell mechanism for mechanically ringing door bells, so as to imitate electric bells, to be applied in houses and other buildings.** Albert F. Rockwell, 77, Chancery-lane, London. (Complete specification.)

14666. **Improvements in electric conduits for street railways.** Jesse Wilford Reno, 77, Chancery-lane, London. (Complete specification.)

14677. **Improvements relating to the application and utilization of electro-magnetism for the separation of metals and to apparatus therefor.** Richard R. Moffatt, 6, Bream's-buildings, Chancery-lane.

SEPTEMBER 18.

14684. **Electrical advertisement moving machine.** Henry Peter Nicolas, Eden Lodge, Beckenham, Kent.

14711. **Improvements in the equipment of craft driven by electricity or any agency other than fluid-pressure.** Thomas George Tagg, 22, Southampton-buildings, London.

SEPTEMBER 19.

14783. **Distribution of the electric current and the current absorbers in installations with multiple conductors.** Woldemar Meissner, 323, High Holborn, London.

14789. **Improvements in internal combustion regenerative thermo-motors, some of which said improvements are applicable to other forms of thermo-dynamic engines.** James Hargreaves, 4, Clayton-square, Liverpool.

SEPTEMBER 20.

14814. **The making and construction of a panoramic electric-lighted automatic advertiser.** William Henry Gritton, 77, Lothian-road, Camberwell, Surrey.

14815. **The making or construction of electrical-covered angle sunk reflective or other letters or signs used for facias, words, names, and advertising generally, to be made in any suitable material.** William Henry Gritton, 77, Lothian-road, Camberwell, Surrey.

14860. **Improvements in automatic telephone devices.** Carl Gust Hoffmann, 18, Buckingham-street, Strand, London.

14871. **Improvements connected with or applicable to baths or vessels containing liquids used in electro plating or dyeing, or the electrolyte of storage batteries and the like.** Edward Hopkinson and David Appleton, 47, Lancashire-fields, London.

SEPTEMBER 21.

14894. **Improved furnace and apparatus for electro-chemical and chemical manufacturers.** Thomas Parker, Wolverhampton.

14932. **A combined cigar cutter and electric lighting device.** Albert Friedlander, 115, Cannon-street, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1887.

747. **Applying electricity to propel vehicles on roads.** Wynne (Complete specification.) 8d.

1888.

12264. **Preparing metallic surfaces for electro deposits.** Elmore and Elmore. 6d.

12856. **Converting electrical currents.** Zipernowsky and Déri 8d.

14941. **Electrical burglar alarms.** Gauge. 8d.

15626. **Electric batteries.** Schoop. 8d.

16141. **Electric contact apparatus.** Tyler. 8d.

16339. **Generating rhythmic electric currents.** Langdon-Davies, 8d.

1889.

10814. **Lanterns for electric lamps, &c.** Keen. 8d.

11075. **Dynamo-electric machines.** Currie. 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name	Paid.	Price Wednesday
12 Feb.	1/2	Anglo-American Brush E.L.	—	—
12 Feb.	2/0	— fully paid ..	—	—
14 Nov.	0/4½	Con Telephone & Main ...	1	3½
27 July	10/0	India Rubber, G. P. & Tel.	10	19½
.....	...	House-to-House	4½	4½
.....	...	Metroptn Electric Supply	—	2½
.....	...	London Electric Supply ...	5	3½
.....	...	Swan United	3½	4½
12 July	12/0	Telegraph Construction ...	12	43½
2 July	6/0	— 6%, 1889	100	105
... ..	...	National Telephone	5	6½

NOTES.

Bacup.—The Corporation of Bacup opposes applications, and will apply for powers themselves.

Exeter.—The Town Council of Exeter has decided not to insist upon underground wires at once, by 24 votes to 11.

Dublin.—The Dublin Corporation have come to terms with the gas company and decided to buy the public lamps.

Stockton.—The Stockton Town Council has decided to oppose applications, and asks for powers for electric lighting themselves.

A Halfway Measure.—The Illinois Railroad uses an electric motor to drive a pump to force gas into tanks to put into the trains to light the carriages.

Edison.—On his return to Paris, Edison received the Commander's Cross of the Legion of Honour, the highest honour that France can bestow upon strangers.

Bournemouth.—The Town Council of Bournemouth has considered the question of taking the power in its own hands, but the consideration has been adjourned.

Holborn.—The Holborn Board of Works has adopted a motion agreeing to allow the Metropolitan Electric Company to carry on the work of laying their mains.

Personal.—We are informed that Mr. Kapp has resigned his position with our contemporary *Industries*, and intends to devote himself entirely to professional work.

Cheltenham.—A special meeting of the Cheltenham Town Council is called for October 21 to consider the question of the adoption of electric lighting by the town.

Underground Telegraphs.—Pipes are being laid from the station to the Grand Stand at Ascot, in order to convey telegraphs now underground instead of by posts as at present.

Doncaster.—The Doncaster Town Council have refused their assent to the proposals of the House-to-House Company, to put down a station on similar lines to that at West Brompton.

Dundee.—At the meeting last week of the Dundee Gas Commission, it was agreed to memorialise the Board of Trade for a provisional order empowering the Commission to supply electric light for public and private purposes within the city.

Chester.—At a special meeting of the Chester Town Council last week, the recommendation of the Watch Committee to apply for a provisional order for the town of Chester was carried unanimously.

Woking.—The works of the Woking Electric Company are progressing rapidly under the superintendence of Mr. Kenneth Mackenzie, C.E. It is expected that a supply will be ready for start in November.

Blackpool.—On Wednesday, Sept. 25, the Blackpool Town Council held the shortest meeting on record—ten minutes—and decided to apply themselves to the Board of Trade for a provisional order to light the town.

Paddington.—The special meeting of the Paddington Vestry will be held at the Vestry Hall, Harrow-road, at 10 o'clock on Thursday next, to consider the ways and means of introducing the electric light by a private company.

The Monster Incandescent Lamp.—We are asked to state that the 3,000-c.p. incandescent lamp, alluded to last week, as used at the Newcastle Museum, was made for

Messrs. J. H. Holmes and Co. by the Sunbeam Lamp Company, of Gateshead.

Deptford.—The arrangements for starting at Deptford are progressing fast, but are not yet complete. Tests have been going forward on the 10,000-volt cables, which are now through, and telephonic messages have been sent along the cable between the offices and Deptford.

Dry Batteries and Bell.—The Gassner dry batteries are now made up in sets with electric bell and push by the English agents, Messrs. Mayfield and Co., and the advantage of being able to place it in any position without spilling is one which is readily appreciated by the public.

Weston-super-Mare.—At a meeting of the Board of Commissioners at Weston-super-Mare last week, the request for the consent of the Board to the application by the Laing, Wharton, and Down Construction Syndicate, for a provisional order for lighting the town, was refused by the Board.

Technics.—As will be seen from our advertisement columns, courses have been arranged for the coming season in civil, mechanical, electrical, and chemical engineering, and other subjects, at the Glasgow and West of Scotland Technical College. Full particulars of the classes can be obtained from the secretary.

Kensington.—Work has just been started for laying the Callender-Webber mains in the Kensington district of the Chelsea Electricity Company, lying in and around Egerton-gardens to the Brompton-road. A large number of houses are being, or have been, wired, and the supply of current will be put on very shortly.

Salford.—The Salford Council have decided to apply to the Board of Trade for a provisional order authorising the Corporation to supply electricity for public and private purposes within the borough, notice having been received that the Manchester House-to-House Electricity Company, Limited, intended seeking this power in the session of 1890.

Henley's Cables.—The new price-list of W. T. Henley's Telegraph Works Company for September, 1889, has been sent to us. This catalogue embodies lists of the various sizes and qualities of these well-known cables with revised prices. It also contains lists of wood casings for electric light mains, which the company are now supplying for all sizes, in whitewood, redwood, and pine.

Gloucester.—At the last meeting of the Gloucester Town Council, the town clerk reported that if the Council proposed either to apply for a provisional order themselves or to consent to the granting of an order to any of the companies applying, it would be necessary to call a special meeting. The Streets Committee have therefore resolved to call this meeting with one month's notice to consider the question.

Lectures on Dynamos.—The series of lectures by Mr. W. B. Esson at Hanover-square will commence on Oct. 16. The syllabus will comprise: units; lines of force; the ideal dynamo; forms of magnets; reaction of the armature; parasitic currents; alternating-current dynamos; direct-current dynamos—open coil, closed coil; Gramme and Siemens winding; series and shunt wound machines; efficient working; dynamo testing, and balance-sheet of energy.

The E.P.S. System.—The silver medal awarded to the Electrical Power Storage Company at the Paris Exhibition is for the E.P.S. system of public supply of electricity from storage batteries (King's patents), the same system which is now at work in the Chelsea Electricity

Supply Company's central and sub-stations in the parish of Chelsea. The distribution is here effected from two sub-stations, and the company has a third sub-station completed, but not yet in operation.

Leicester.—A special meeting of the Leicester Town Council has been summoned for October 29, to confirm a resolution already adopted in favour of applying to the Board of Trade for a provisional order to empower the Corporation to introduce and supply the electric light for public purposes. The Council already own the gas works, which last half-year produced a net profit of £13,000, thus raising the entire amount derived from this source towards the relief of the local rates to over £130,000.

Cable v. Electric Cars.—St. Louis tramways discarded horses and took to cable lines. The result was their shares went up from 160dols. to 350dols., and the surrounding property increased in value 25 per cent. They are now, to obtain still further improvements, about to discard the cable system, and have contracted for an installation of the electric motor system. The electric system is also about to replace the cable in Kansas City. These facts speak eloquently of the efficiency of electric traction.

Pocket Voltmeter.—Messrs. Mayfield have shown us a pocket voltmeter which they have just completed, which promises to have an extended usefulness for electrical engineers. This instrument, which is of the size and shape of their voltmeter recently described, now ranges up to 120 volts, a capacity, there is hardly need to point out, which makes it of great convenience for most ordinary installations. The instrument is of the size of a rather large watch, and is neatly finished and nickel-plated.

School of Electrical Engineering.—We are informed that, as the result of the examinations for the certificate of the School of Electrical Engineering, Princes-street, Hanover-square, recently conducted by Mr. Gisbert Kapp, A.I.C.E., the following gentlemen have obtained the certificate in electric lighting and power transmission: Messrs. H. E. Bartlett, S. Bone, J. H. Bornver, jun., J. A. Fraser, W. C. Goodchild. The candidates passed in two papers, in mechanical and in electrical engineering, and also a *viva voce* and practical examination.

Electrical Premises.—It will be seen from our advertisement columns that the lease of the large premises in Golden-square, W., recently occupied by the late Sir Charles Bright, are offered for sale, and also the electrical and other instruments, engine, dynamos, and batteries, etc., as already fitted, with other accessories. The premises are, of course, well known in conjunction with electric undertakings, and might be exceedingly convenient either for a private practice or for an office of a company, or for a technical school or other purpose.

Brockie-Pell Arc Lamps.—The Brockie-Pell arc lamps, made by Messrs. Johnson and Phillips, are giving great satisfaction, and are being widely adopted. We hear that 75 of these lamps are about to be put in the sorting rooms of the General Post Office, St. Martin's-le-Grand. Twenty-five are also being supplied to the Natal Harbour Board, and other supplies for colonial use are being sent out. The firm have export orders on hand for some four or five hundred of the Brockie-Pell lamp, and we are pleased to find the prophecy of Prof. Thompson at the Society of Arts as to its merit is justified by the results.

Old Students' Dinner.—The fifth annual dinner of the City and Guilds of London Old Students' Association will

be held at the Manchester Hotel on Saturday week, October 12. These dinners are a very agreeable *réunion* of the past students of Finsbury and Kensington Technical Colleges, and many now very well-known and active members of the electrical and engineering profession gather round to meet each other and their erstwhile preceptors for social intercourse and to report progress. We trust there will be a large attendance, and that all members who possibly can will attend. The tickets for the dinner, price 4s., are to be obtained of the hon. secretaries, 14, Garfield-road, S.W.

Telephones in Austria.—Long-distance telephonic communication was opened on Tuesday in Austria between Vienna and Prague, a distance of 220 miles. Every subscriber in Vienna can now communicate with Prague, and every word can be perfectly understood and the voice recognised. In connection with this news the London *Star* gets rather a good joke on the *Daily News*, who first announced the opening. Their correspondent mentions as a curious fact that it has been observed that those who listen at Prague hear more clearly than those who listen in Vienna, and remarks the reason has not been explained. The *Star* heads its paragraph "They speak plainer in Vienna," and says the reason seems clear enough.

Utilising Niagara.—A definite scheme, under the name of the Niagara Hydraulic Electric Company, has been organised at Alexandria, Virginia, for the purpose of utilising the water power at Niagara Falls. It is stated that the company has secured from the Ontario Government the right to use the water at the Horseshoe Falls on the Canadian side, and that they intend to secure their power by tunnelling through the rocks to the bed of the river, thereby obviating danger from ice and wreckage, and also leaving undisfigured the beauty and the scenery. The company proposes with the power secured to furnish light, power, and heat to various points within a radius of 40 miles.

Electrical Construction and Maintenance.—The mammoth combination, the Electrical Construction and Maintenance Company, have taken quite palatial offices in Worcester House, Walbrook, where they have just held their first statutory meeting, as reported elsewhere. We notice Mr. Tarver's name appears once more, and we shall be interested to see if this gentleman has an office in the building. He is probably, however, of too retiring a disposition. We learn that great endeavours are being made to get the affairs of the E.P.S. Company into spick-and-span trim, so that they may be handed over on the 31st of this month, and will remove to these offices, to which all orders in future will be addressed. The E.P.S. Company are, we believe, very busy, orders for accumulators for all purposes constantly coming in.

Post Office Telephones in the North.—The Post Office authorities have commenced their new arrangements with regard to telephoning in the North of England. On and after the 1st of October their telephone wires between Newcastle, North and South Shields, Jarrow, Tyne Dock, Sunderland, West Hartlepool, Stockton, and Middlesbrough may be used by the public on payment of a fee of 6d. for a conversation not exceeding three minutes. People can thus communicate with persons who have already joined the Telephone Exchange, and they can also, by means of "silence-boxes" placed at the various post offices, carry on a conversation with others by directing them to attend at the silence-box at the other end at a particular time. In

the case of communications between persons in the same town, the fee for a talk of not more than three minutes is fixed at 3d.

Western Counties Telephones.—Steady progress is being made in Torquay and the neighbourhood in the matter of telephonic communication. The number of subscribers to the Torquay Exchange, according to the *Western Morning News*, has now reached about 140, and the average daily calls are between 400 and 500. Increasing use is also being made of the telephone in the surrounding towns, thereby furnishing ample proof of the fact that the value of this simple and effective method of speaking is being very generally adopted. The recent extension of the telephone from Torquay to Plymouth has excited much attention on account of the comparatively long distance—forty miles—between the two towns. The line is perfectly clear and free from any interruption whatever, and a conversation can be carried on with almost as much ease as between two persons in the same town.

Paper Tube Insulation.—A new system of insulating electric wires is reported as about to be adopted in the new opera house at Philadelphia. The material used is the new fire and waterproof paper insulation mentioned last week. The paper compound is made in tubes, which can be easily laid in the plaster of new buildings, for which purpose it will generally be used. The paper tubes do not affect the appearance of walls or ceilings. The tubes are very smooth inside, and after being set in the structure the wire can be easily pulled through by a cord. The cord is not threaded in the tubes at the time of laying, but is passed through in a simple and ingenious way. The cord is attached to a small ball, which is then blown through from one end of the tube to the other, and the wire is then pulled in by the cord. The system presents some obvious advantages in certain situations, and no doubt, if thoroughly practical, will extend.

Electrical Gold Extractor.—A party of engineers and persons interested in gold mining in South Africa, Australia, and other parts of the world, visited Grantham by invitation last week, to inspect the works of Messrs. R. Hornsby and Sons, Limited. The party, which numbered about 100, arrived at Grantham Station by special train from London, shortly before noon, and at once proceeded to inspect the works, which can be entered from the railway company's premises. Amongst the various attractions the interest of the visitors centred in a machine called "Cousen's patent electrical gold extractor," which, by means of electricity, extracts gold from the pyrites and other gross metals. The company included General Fielden, and Messrs. Vanderbilt, Robinson, Exstein, and Nield. Subsequently, a luncheon was given at the Town Hall, over which Mr. James Hornsby, managing director of the firm, presided.

Booming Electric Shares.—One of the events of the week has been the sudden rise in electric shares, noticeably Edison-Swan shares, $3\frac{1}{2}$ paid, which from the recent $3\frac{1}{2}$ have risen at one time to $6\frac{1}{2}$, nearly 100 above par, and remain yesterday $5\frac{3}{4}$ to buy and $5\frac{1}{2}$ to sell. We do not think the price too high when it is considered the very considerable profit made last year, and the fact that if the central stations commence this winter there may be a demand for at least half a million lamps for this winter's fresh outfit, besides possibly another quarter million replacement of existing lamps. The incandescent lamp has had a long pull, but is beginning to feel the benefit. The London

Electric Supply shares also went up to par, so that it may be seen there is some excitement in the Stock Exchange world. It is to be hoped, however, that the rise will not cause a rush to send the shares up to a fictitious value, which would only result in another disappointment to the public.

Walsall.—At the last meeting of the Walsall Town Council, the Electric Lighting Committee recommended that the right to supply electricity be vested in the Corporation. The Mayor mentioned that three companies had applied, but after communication with each of the three companies, that committee had come to the conclusion that it would be best for the Corporation themselves to apply for the necessary order, as they believe that they would be able to supply the light on better and cheaper terms than a company, while they would not be pledged to any particular system, but would be in a position to avail themselves of the best system that science was able to produce; and the committee recommended that the Council make application for the necessary order, the cost of which it is estimated will be from £250 to £300. The committee also recommended that the Council oppose the grant of an order to any of the companies. The resolution was carried unanimously.

Leeds.—The Electric Lighting Committee submitted to the meeting of the Leeds County Council on Wednesday a report giving particulars of the annual cost of the existing Corporation installation of electric lighting, and also as to the cost of the light in certain boroughs where it is in operation. As the present Leeds Corporation installation is in an unfinished condition, no definite figures, says the report, can be given, but when the whole is completed, there will be about 3,000 lamps installed at a cost of about £7,450. The annual cost will then be £2,605, made up as follows: Depreciation $7\frac{1}{2}$ per cent., £558. 15s.; interest and sinking fund 5 per cent., £372. 10s.; wages, £280; fuel, £267; water, £78; oil waste, £72; lamp renewals, £730; repairs $2\frac{1}{2}$ per cent., £186. 5s.; ashes removing, £60; total, £2,605. This is equal to .208 pence per hour, or less than $\frac{1}{4}$ d. per lamp per hour. The Council had before them a motion that they should apply to the Board of Trade for a provisional order, but, after some discussion, the motion was adjourned for six months.

Sheffield.—A special meeting of the Sheffield Town Council was held last week to consider the request of the present Sheffield electric light company, for consent to their application for a provisional order. The Mayor, however, stated that at a meeting of the Improvement Committee a resolution was carried recommending the Council to send the same answer to the application as was sent to the one from the Electric Construction and Maintenance Company, Limited—namely, that the Council will not give their consent to any license or provisional order being granted to the company for supplying electricity in Sheffield, on the ground that the Council might probably itself seek to obtain powers necessary for that purpose. The Mayor moved a resolution to this effect, remarking that it was not desirable at present to allow any company to get a footing in Sheffield, because in the course of a very short time they would have to take up the question as a Council and deal with it. Therefore they should keep their hands free. The resolution was agreed to unanimously.

City Lighting.—On Tuesday a special meeting of the Commissioners of Sewers was held at the Guildhall with reference to the subject of electric lighting. The proposal

by Mr. Sly was carried: "That the report of the Streets Committee of July 30, on electric lighting and the abstract of tenders be printed and circulated among the members of the Commission." Colonel Haywood said he did not think the report would give all that was required, and for that reason a specification was prepared. Companies had sent in their tenders, but nearly all the companies had made modifications, so that they did not strictly agree with the conditions the Commission had drawn up. There was information as to the modifications suggested which it would be well the Commission should have. Mr. Pannell then moved, in addition, that the engineer and Mr. Preece be requested to amend the abstract of tenders, so as to make it uniform with the conditions under which the various companies are now prepared to contract. They would then have each of the companies' proposals before them. The Commission then adjourned.

High or Low Tension.—Enquiries of all sorts of town installations begin to pour in for districts various—large and small, scattered and compact. It behoves our electrical engineers to carefully consider the merits in each case, and not be run away with on the advocacy of any one particular system. The margin of profit and the first expenditure can, or should be, accurately determined for varying circumstances, and the balance between the cost of laying large mains with much copper for low tension, and the cost of laying small mains with little copper, but with many transformers for high tension, resolves itself eventually into a similar question to that as to whether lamps should be burnt up faster when power is scarce, or whether power should be wasted where lamps are high priced. The circumstances under which each system is the better should admit of very close calculation, and it would not be well for the general status of electric supply that mere party advocacy, irrespective of requirements of one or of the other system, should carry the day in the ears of town councillors.

The Post Office and the Telephones.—Says the *Financial News*, in reference to a paragraph we published last week: "When the Post Office exacts a royalty of 10 per cent. of the receipts of all telephone companies, it is a little unfair that it should also enter into competition with them. The Western Counties and South Wales Telephone Company has a strong grievance against the department, which announces a competitive telephone service after October 1 between the principal towns in South Wales. It is very hard that a telephone company should be milked at both ends by the Post Office, especially as the royalty was imposed as a species of compromise for the relinquishment of the Government's monopoly where private companies were already serving the public well." It does seem hard from one point of view certainly, but there is another, and that is that telephoning between towns is practically telegraphing. The Post Office have the monopoly of telegraphing, and have let the telephone companies under a royalty come in and take part of their business. The question is without doubt an important one and one which must come to a head some time, and that before very long.

Increase of Prices.—One result of the dockers' strike in London has been the rise of prices of labour in various other trades. The strike at Silvertown has caused other demands to be made, both in London and in the provincial towns, which can only result in the rise to some extent of cost prices. Messrs. Binswanger, at Manchester,

have experienced considerable difficulty with their workmen, and have raised their men 15 to 20 per cent. all round. This, it is pointed out, must necessarily result in increase of prices, and goods and fittings will not be able to be always obtained at the same low prices as before. Contractors and others who are basing their estimates on these or similar prices, would do well to take these signs into account and not tender at the absurdly low and cutting rates that for some time past have been too prevalent, or even the present very low rate of profit some contractors have been content with will be found to have disappeared. The increased cost price and the increased demand which must now necessarily ensue on the throwing open of the large central stations in London, should lead to less competition and better prices for fitting; and in all cases the desirability to the householder of having thoroughly good work at a fair price should be insisted upon.

Acme Electric Works.—We were up the other day at the Acme Electric Works, and found Mr. Cockburn very busy. He is making arrangements to open a new West-end depot and showroom in Princes-street, Hanover-square, a locality already classic to many electrical men. We learn also that the firm are busy with the new twisted hot-wire voltmeter of Prof. Perry, recently described, which is expected to work wonders, and the firm are appointed sole manufacturers. The Cockburn fuses are now reduced in price, a fact that may lead to their still further adoption. A new form of fuse has just been patented, and is being introduced, which embodies several advantages. The fuse, in the first place, is on the lid and not in the fuse-box itself, thus obviating all niggling with fingers or screwdriver to fix a new one. The fuse itself, with the lead weight as before, according to Cockburn's patent, is connected to two blocks on the lid, from which project studs, which fit into sockets in the fuse-box, to which the wires are connected as usual. To replace a fuse, therefore, the lid is taken off and the fuse can be replaced while the current is on without fear of shocks. It is also very easy to inspect the circuits at any time by simply taking off the lid by the fingers. These fuse-boxes, with Bathurst's crossover blocks for all junctions, make the small details of wiring very complete.

Accumulator Cars at Canning Town.—On Tuesday morning the last of the five accumulator cars of the Electric Traction Company was put on the North Metropolitan Tramway at Canning Town, and the whole of that line is now worked by electricity. For some weeks or months past the cars have been added one by one to work among the horse cars, and that the amount of running done by these cars is not small can be best seen by the figures, which show that 15,000 car miles have now been run upon this line, with only a loss for stoppages of 2 per cent. of the total possible mileage. The Board of Trade inspector has again visited the line, and reported that all arrangements have been made for safe running, and from the 1st October the cars will be run for the stipulated three months for the North Metropolitan Tramway Company to ascertain accurately the cost of running. It is satisfactory to hear that so far the manager of the tramway company has expressed great belief in the future of these cars for the London tramways. The cars carry a complement of 52 passengers inside and out, and have carried as many as 80 persons on a test run. It will be remembered that at Brussels a small tramway runs a few cars with accumulators. These, however, are not run exclusively, and only carry about a score of pas-

sengers, having no outside seats. The Canning Town line is thus practically the first and only line which is running accumulator cars regularly in Europe.

Paris Converts Leamington.—Mr. Councillor Fell hit the right nail on the head when he said that to go back to gas would be a great mistake, and would place Leamington in a very peculiar position to go backward when other towns were going forward. He suggested they should not spend more money in going back to gas, but should keep up a tentative agreement, and look around at what was being done in other towns and see what they could do for Leamington. He added that the other day he had received an offer, without any solicitation, from the manager of a firm offering to supply 100 arc lamps, 30 of which should be 2,000 c.p., for the same price they were now paying for the electric light, and for about £100 more than they would have to pay under the new system of gas. Councillor Harvey remarked that it was well known that he was one of those that had spoken of the electric light as a failure. During the last month, however, he had been to Paris, and come to the conclusion that it was really the light of the future. He gave details of Paris, Taunton, and the Birmingham Exhibition, and said he was quite convinced that it was possible to light Leamington with efficiency and economy, and if they reverted to gas now they would, in a very few years, have to go back again to the electric light. Even Councillor Crowther Davies relented and said nothing would rejoice him more than to know that there was a reasonable hope that the electric light would prove a success in the borough; and he would now, with very great pleasure, fall in with the suggestion that the determination to revert to gas be deferred. The report was referred back to the Watch and Lighting Committee for further consideration. Leamington may, therefore, have its electric light yet. We are pleased to find such a reasonable spirit showing itself, and the Paris Exhibition cannot be said to have failed of a practical result to English lighting.

Electric Motors at Central Stations.—One of the most striking points of the electric development in America was the remarkable activity displayed by the electric motor men. No sooner was a central station established than the motor man was on the spot. Ventilating fans, boot-brushes, hairdressers' brushes, knife-brushes, were all fitted with the busy motor. Motors on a larger scale were fitted to lifts, to water pumps, and to driving mangles. It has been used for printing presses, for driving lathes. To get larger still, it has been used for flour mills, and for driving machinery, and for hoisting coal. Now, in England, central stations with direct-current systems are beginning to be opened. Kensington has been running for some years, yet we hear of no applications for motors. Bradford was opened with great *clat* the other day, and were the motor men on the field? As far as we know, the names we have been accustomed to associate with motor work were absent, and have hardly stirred. Messrs. Siemens no doubt will be on the field, and will receive orders simply because they are engineers to the Corporation, which might be better canvassed for and seen to by some enterprising motor specialist. If the motor business is to spread, business tactics will have to be employed. Do we think Messrs. Crossleys would have sold their thousands of gas-engines if they had had no agents in the towns where gas was supplied, and had not taken good care to have a silver-gilt gas-engine in a front window on

the best thoroughfare for all to see. When the business men thoroughly realise that a small piece of machinery the size of a hat or a coal-scuttle can do a good horse-power of work for them, by connecting first with the electric wire and secondly with a belt to their machines, they will soon buy and use them. If the electric supply is used up by motors so much the better, and the sooner they will have to extend. Therefore, to makers of motors there are two questions: Is business brisk enough? Do we intend to have any of the business that is coming?

Barnsley and the Gas Question.—An exciting meeting was held on Wednesday, at Barnsley, to consider the recent attempted advance of the gas company and to suggest remedies. Two resolutions were before the meeting: (1) "That in the opinion of this meeting the advance in the price of gas is uncalled for, and this meeting pledges itself to use every legitimate means to oppose it." (2) "That considering the unwillingness of the gas consumers to submit to the proposed advance in the price of gas, the Town Council is hereby strongly urged to push on to a speedy conclusion their deliberations on the subject of the electric light." Mr. C. Wray went into the comparative prices of gas at various towns, saying that at several places in Barnsley they were charged exactly double the price at Sheffield, and proposed the first resolution, which was seconded by Mr. Wm. Tune. He said the original stock of the gas company had for many years been worth 300 per cent. premium. Since 1852, 20 per cent. had been paid on the original stock of the company. About that time they had made so much extra profit that they presented every shareholder with an equal number of fully paid-up shares, without calling upon those shareholders to pay a single penny. In 1867 they got a bill to increase their capital and extend their works. They spent a precious deal more money than their business required, because they knew they could get double interest on the gas shares than on any other investment. He urged the importance of resisting this monopoly, and urged there was no necessity for it. Mr. J. Charlesworth supported, and said he would not go further than 2s. 6d. for the price of gas; bills ought to give particulars, and meters ought to be reduced to half price. Alderman Blackburn, as chairman of the Park and Lighting Committee, defended the committee's action, and said they had had applications from three electric lighting companies, but they thought if it would be profitable for electric companies it might be profitable for the Corporation. They wanted no more monopolies. They would go to various towns to see which was the best light; they would take advice, and would then draw up an exhaustive report, and if they found they could give the electric light almost as cheap as gas, then the committee to a man would say to the Corporation, "Do not let any more monopolies come to Barnsley; do not have any electric companies, but start an installation yourselves and make your profit for the town." Mr. G. Wheelhouse then moved the second resolution, and pointed out how the extra 4d. would mean an advance of £70 on the £500 which the Co-operative Society paid annually for gas. He quoted cases where prices of gas were much less than in Barnsley. He pointed out how they had had the electric light for five years at the Co-operative Society's mill without any mishap, and said they could have for Barnsley a 33 per cent. better light for 20 per cent. less cost. Mr. D. Calvert seconded the resolution, and it was carried unanimously, and votes of thanks concluded the proceedings.

NEW YORK NOTES.

(FROM OUR SPECIAL CORRESPONDENT.)

*The Telephone Convention,
Half-Open Doors.
Papers Published, Discussions Secret.
A Condensed Textbook on Long-Distance Telephony.
Underground Work in Brooklyn.
Long-Distance Lines with Earth Return.
Telephone Salutations.
The Aggravating "Hello" Condemned.
Telephone Work Abroad.
Nothing to be Learned, Much to be Taught.
Thirteen Months of a Switchboard's Life.
Drawbaugh to the Fore Again.
Those Deadly Wires.
Electric Light Wires on the Rampage.*

NEW YORK, September 21, 1889.

The eleventh meeting of the National Telephone Exchange Association has been held and is a matter of history. Nearly 100 delegates were in attendance, of whom 18 hailed from New York, 12 from Chicago, and nine from Boston. A great deal of business was transacted and some very interesting papers were read. The delegates and their wives and daughters were most handsomely entertained by the Minneapolis telephone authorities; drives round the town and neighbourhood were organised, and the proceedings terminated with an elaborate banquet, which was a pleasant and suitable wind-up to the conference, everyone being in the best of spirits if we may judge by the numerous entertaining, poetical, and humorous speeches delivered by various members of the association and their hosts.

The proceedings of the convention were conducted with closed doors, but, as a matter of fact, only the discussions were withheld from the public, as all the papers have been printed. This desire for secrecy on the part of the convention is viewed by many as being wholly unnecessary, and is adversely commented upon in a very pithy editorial in the *Electrical World*, under the apt heading of "Half-Open Doors." It certainly seems a curious policy to permit the publication of the papers and maintain strict secrecy in regard to the discussions, and uncharitable folk might view this attitude of the convention in anything but a complimentary light.

The *pièce de résistance* of the convention was the paper on long-distance telephony, entitled, "A New Era in Telephony," by A. S. Hibbard, J. J. Carty, and F. A. Pickernell, in which a minute and exhaustive description was given of the methods employed in the construction and maintenance of the long-distance system by the American Telephone and Telegraph Company. This paper is a textbook on long-distance telephony in a condensed form. Every detail of the system is touched upon, and many are described *in extenso*. Starting with a description of the special form of instrument in use for long-distance work—which is made up in the shape of a small desk—the battery and office wire, and the method of bringing in the leading-in wires, are dealt with; terminating the cables, lightning-arresters and fusible coils, underground cables and their proper arrangement in the subways next claim attention. The proper designing of a telephone building for an exchange is treated of in detail, and many valuable suggestions are made. Switchboards and methods of operating and the arrangement of metallic circuits occupy a large proportion of the paper, which is one that every telephone engineer should read. I have given merely a table of contents, as the paper is a very lengthy one. To make any abstracts of particular passages would be invidious, so valuable is it as a whole.

Mr. J. C. Reilly, of the Brooklyn Exchange, gave an interesting *resumé* of the past year's underground work in Brooklyn. Mr. Reilly has to deal with 38 miles of cable, 24.3 of which are underground, and 13.7 suspended in the elevated railway structures. These 38 miles of cable contain 3,634.6 miles of conductors. The subways are excellently ventilated by means of branches to poles and housetops and to the columns of the elevated railway, and by this simple precaution, Brooklyn has been kept free from subway explosions. Mr. Reilly pointed out

that the destructive effect of creosoted wood upon the lead covering of the cables disappears almost entirely after a few years. Experiments were made with creosoted wood which had been in stock over two years, and some only about eight months old. It was found, after three months' trial, that, whereas samples of cable which had been enclosed in a box made of the two-year-old wood only showed infrequent patches of phenolate, the effect of the lately-creosoted wood was much more marked, the samples of cable being thickly coated with phenolate.

A short paper was read by Mr. Flemon Drake on "Switchboards and Long-Distance Lines on Grounded Circuits." Mr. Drake stated that his company work circuits up to 145 miles long with earth return, and expect shortly to be attempting to work one of 210 miles. He also said that he was confident that they will find it desirable to adopt metallic circuits for all routes extending 100 miles or more. It would be better for the company and better for the customers, and business could easily be increased fifty per cent. thereby.

Mr. R. M. Bailey read a short paper on "Telephone Salutations," in which he deprecated the use of the word "hello" in the following terms: "With intelligent people, as well as with others not so intelligent, and with telephone experts in a great measure, it is customary to stand at one end of a telephone line and, by reiterating the word a great number of times in quick succession, entirely drown out the fellow's voice from the other end of the line, and he, by going through a similar formula with energy and patience frequently mixed with anathemas against the telephone, succeeds in slowly getting into actual conversation, while the fault lies entirely with the individuals and not with the innocent machine. What would be thought of an individual entering an office or premises of any kind, knowing and seeing the proprietor there present, should he begin and persist in calling attention by repeating over and over again the word 'hello'?" Mr. Bailey proposes to eliminate the obnoxious hello by having users of the telephone announce their name or that of their firm as the only preliminary.

Mr. W. D. Sargent read some remarks on the telephone exhibit at the Paris Exhibition, and on telephone work abroad generally. In conclusion he said, "I could not learn from any of the electrical people whom I met abroad, that any plans had been made for a general system for placing a telephone exchange network underground. My impression is that we have little or nothing to learn abroad, and that it will not be long before the requirements of the business in London and other large cities will necessitate placing the wires underground, and that we will be able to teach them many things when that time comes. Mr. Sargent then read a long and exhaustive report by Mr. G. J. Davison, manager of the Brooklyn office, on the working of the single-wire multiple switchboard, which was installed in the Brooklyn Exchange thirteen months ago. During this period the switch and its equipments have required attention on 1,115 occasions. Of this number 275 were confined to the cords, the remaining 840 being in connection with the mechanical parts of the switch.

Mr. T. D. Lockwood said in his speech at the banquet given to the delegates of the Telephone Convention that he did not think that anybody now really doubts that Prof. Alexander Graham Bell invented the telephone. There are some people, however, who evidently doubt it very much, as another big telephone battle has just been inaugurated at Washington between the Drawbaugh interests and those of Bell, and, according to all accounts, will be fought out to the bitter end. All the different Drawbaugh interests have been united under the direction of a syndicate with strong financial backing. The syndicate talks very big and is confident of a success as it now has the Government for an ally, the Government counsel having brought a suit for fraud against the Bell Company, setting up the rights of Drawbaugh as a correlative charge.

There have been several accidents lately caused by electric light wires, and two deaths have occurred during the past week from persons coming in contact with overhead wires carrying heavy currents. The sensation-loving reporters of the most sensational press in the world have positively revelled in all this: "those deadly wires,"

"electricity and death," and other similar catching phrases stare us in the face on contents bills and at the head of columns of romantic matter almost every day. Last Friday an Italian fruitseller climbed up on an iron awning to liberate the water from a choked-up gutter. Immediately above the awning passed a number of electric light wires; the man slipped and fell, catching at some of the wires as he fell, and was killed by the current. The body lay across the wires for some twenty minutes before they could be cut, and when this was done it was found that a wire had burned deeply into the flesh of the unfortunate man's neck. The other death recorded was that of a lineman in the employ of the Brush Company, who, while mounted on a ladder executing some repairs, caught hold of a live wire and was thrown to the ground by the shock. He sustained such severe injuries from the fall that he died the same night in the hospital to which he was removed. Numerous instances are reported of loose wires having come in contact with iron posts and railings, inflicting shocks on all and sundry. A few days ago a horse was knocked down by a shock received by stepping on the end of a broken wire, and a police-sergeant met with the same fate on touching the station telegraph, the telegraph line having got crossed with an electric light wire. These accidents are all, more or less, directly due to the recent storm.

GREATEST DEPTHS OF THE OCEANS.*

Atlantic.—Rejecting some of the earliest soundings as untrustworthy, the greatest known depth in the North Atlantic is to the north of the island of Puerto Rico, in about latitude 19deg. 39min. N., longitude 66deg. 26min. W., found by the C.S.S. "Blake," Lieutenant-Commander Brownson, U.S.N., in 1882-83, 4,561 fathoms.

The deepest known spot in the South Atlantic is 3,284 fathoms, in about latitude 19deg. 55min. S., longitude 24deg. 50min. W., sounded by the U.S.S. "Essex," Commander Schley, in 1878.

The general run of the soundings indicates that greater depressions exist nearer the western than in the eastern or middle part of the Atlantic—North and South.

Pacific.—In the North Pacific, the greatest depression has been found by the U.S.S. "Tuscarora," Commander Geo. E. Belknap, U.S.N., in 1874, 4,655 fathoms, in latitude 44deg. 55min. N., longitude 152deg. 26min. E. The next deepest sounding in the North Pacific was located by the "Challenger," in 1875, 4,475 fathoms, in latitude 11deg. 24min. N., longitude 143deg. 16min. E. As in the Atlantic, the greater depths appear to exist in the western part, and particularly off the coasts of Japan.

In the South Pacific the greatest depths were supposed, up to a recent period, to be in the eastern part. Within the last two years, however, the British surveying vessel "Egeria" has discovered greater depressions in the western part of the South Pacific, one spot sounding 4,430 fathoms in latitude 24deg. 37min. S., longitude 175deg. 08min. W., and another 12 miles farther south, 4,298 fathoms.

Indian Ocean.—In this ocean the greatest depths appear to exist to the north and west of the Australian continent, where there are more than 3,000 fathoms in a number of widely separated spots, indicating a depressed area of considerable extent.

In the southerly part of the Indian Ocean, or rather in "antarctic region," the "Challenger" obtained, in 1874, a maximum depth of 1,673 fathoms in latitude 65deg. 42min. S., longitude 79deg. 49min. E.

Arctic Ocean.—The greatest depth was sounded by the "Sofia" in 1868 (2,650 fathoms), in latitude 78deg. 05min. N., longitude 2deg. 30min. W.

In the minor seas the maximum depths so far as ascertained are: Caribbean Sea, 3,452 fathoms, south of Great Cayman (Sigsbee Deep); Gulf of Mexico, 2,119; Mediterranean, 2,170; North Sea, 375; Baltic, 178; China Sea, 2,100; Coral Sea, 2,650; Sulu Sea, 2,550; Celebes Sea, 2,600; Banda Sea, 2,800.

* Extract from report by the Hydrographer, United States Government, dated January, 1889.

BOROUGH OF STAFFORD.

The following is the Gas Engineer's report, as presented by the Town Clerk to the Stafford Town Council:

1. In my opinion it would not be advisable to erect a central electric lighting station unless there is a probability of a minimum of 2,000 (16 c.p.) incandescent lamps being required within the area of supply. I have scheduled the streets, etc., which might advantageously be comprised in the first area to be dealt with. Unless sufficient consumers can be obtained within that area who will undertake to pay for not less than six (16 c.p.) incandescent lamps each during a period of two years at a fixed price per light, and making an aggregate number of lights equal to 1,200 (16 c.p.) lamps and yielding a revenue of at least £2,400 per annum, the Town Council would not be justified in establishing electric light works. It is not probable that any company would erect works for a smaller installation. Certainly a less number of lights could not pay working expenses and yield reasonable interest on capital expenditure.

2. The Corporation have sufficient land on the east side of the gas works for the establishment of a central electric lighting station, and being near the centre of the town it would be an excellent site, and it will not be required for gas works purposes.

I have obtained a large amount of valuable information on the working of the two systems now in use for electric lighting from central stations—i.e., alternating transformer and accumulator transformer distribution—and which I will now refer to respectively as the "A.T." and the "B.T." systems.

In the "A.T." system the electricity is generated by means of an alternating-current dynamo, and the distributing plant consists of two mains running round the circuit, and which are charged direct at an E.M.F. of pressure of 1,000 volts and upwards. The electric energy is then converted by means of transformers into a current of 100 volts or less to supply either one or more consumers using from 6 to 100 (16 c.p.) glow lamps within a short radius.

The "B.T." system is the distributing of a continuous current of electric energy by means of secondary batteries. The electricity in this case is generated by a continuous-current dynamo, which charges a single circuit at a high E.M.F., and at different points on this circuit are secondary batteries or accumulators. These consist of 53 cells, which have been termed appropriately "reversible" because they can be charged and discharged without the addition of fresh chemicals. In other words, they store up the electric energy. If this method of supplying electricity were adopted, it would be necessary to divide the current from the central station by means of sub-stations placed at different parts of the circuit, which would contain these storage batteries. The mains could then be run from 200 to 300 yards from these secondary batteries, so as to supply any lights required on the small circuits.

The opinions of electricians are divided on the merits of these two systems, but it appears that the "A.T." system is being more largely adopted than the other. The advantage of the "B.T." system is that the electricity can be stored, so that breakdowns in the machinery would make no difference in the lights; also the electricity can be generated during the daytime ready for evening consumption; but, unfortunately, these storage batteries require a large amount of skilled attention, and the automatic governor for regulating the charging of the cells is delicate and liable to get out of order. Further, the depreciation of these cells is a factor of some importance.

The "A.T." system is a comparatively simple mode of distributing electricity, but in case of any breakdown in the machinery the supply of electric energy would fail; also the machinery has to be kept in motion, although only a few lights may be actually required. If a constant supply is required, the machinery must be kept running continuously. Still, if the Corporation erect a central station, I am inclined to recommend the "A.T." system. As a rule, the consumers would probably not object to the supply being off from midnight until lighting time the following day, as is now done by the Exeter Electric Light Company. Provision could, of course, always be made for exceptional seasons or occasions, so as to provide continuous lighting. The cost of either system for capital expenditure would be practically the same, and it is not necessary now to finally decide the system. On the whole, however, I believe the "A.T." system has advantages which would make it the best for Stafford, and the cost for working expenses and maintenance would probably be less than the "B.T." system.

Accordingly I estimate for a complete alternating transformer distributing system to supply a minimum of 2,000 (16 c.p.) incandescent glow lamps, the electric station to be established by the side of the gas works, and to be worked in connection with same. Now as regards the motive power which will be required to drive the dynamos. Where a convenient water supply can be obtained from natural sources, as in the case of a river, with sufficient fall and discharge, it is, of course, the best and cheapest method to employ for power. These conditions unfortunately do not apply at Stafford, and we need only consider the question of steam or gas engines, which must be of 300 h.p., to work three dynamos up to their full capacity. The adoption of gas-engines, working during the summer months with ordinary lighting gas and in the winter with producer gas, would be a very cheap mode of obtaining power. Gas-engines worked by means of Dowson's fuel gas give an efficiency of $1\frac{1}{4}$ to $1\frac{1}{2}$ lb. of coal per indicated horse-power per hour, which is less than one-half the fuel account of best high-pressure compound steam-engines, even when worked under favourable conditions. However, as we should require engines each capable of working up to 100 h.p. without undue wear and tear, I do not feel justified at present in recommending gas-engines, for as I should propose lighting direct from the dynamos, we must have engines such as will run perfectly steady and be well able to stand the heavy work of driving

dynamos. For small installations Otto gas-engines are doing good service, but I feel it necessary to have more information on the working, both as regards steadiness and reliability, of such large gas-engines as 100 h.p. before I take the responsibility of recommending them. The capital expenditure for equal steam or gas power would be practically the same, but the cost of working the latter would be much less than steam. For the present I base the estimates for motive power upon the cost of obtaining and working three 40 n.h.p. high-pressure compound horizontal steam-engines, each of which could easily be worked up to 120 h.p. when running at a moderate speed.

The boilers to be of Lancashire type, made of steel, and to work at an initial steam pressure 120 lb. per square inch. The machines used to generate the electricity to be three alternating current dynamos, each capable of supplying 1,050 (16 c.p.) lamps, after allowing 10 per cent. for loss in leads and converters, when running at a speed of 480 revolutions per minute, along with exciters running at 800 revolutions per minute.

The current to be divided into three circuits working at an E.M.F. or pressure of about 1,000 volts, and distributed to consumers by means of converters—these reducing the current to 100 volts, or less, if required.

In accordance with the foregoing general description of an "A. T." central electric light station, I now give estimated cost of such an installation:

Buildings, which include engine and dynamo-house, boiler-house, chimney, etc.	£1,250
Three 100 h.p. high-pressure compound steam-engines, with 14in. and 24in. cylinders by 36in. stroke, fixed complete	2,250
Two 30ft. by 7ft. 6in. Lancashire steel boilers, steam-pipes, fixing, etc.	1,000
Three alternating-current dynamos complete, with exciters, each capable of supplying 1,050 (16 c.p.) incandescent lamps	2,250
150 transformers	1,500
Charging and distributing mains	5,000
Regulating and testing instruments	250
Contingencies	1,000

Total cost...£14,500

The above is an estimate for a complete central electric lighting station capable of supplying 3,000 (16 c.p.) incandescent lamps, so designed that when the lights reach about that number another 1,000-light dynamo and steam-engine could be added, and so on for each additional 1,000 lights, always having sufficient spare engine and dynamo power in reserve in case of a breakdown or stoppage of the other machines.

3. To compare the cost of electricity as against gas, having equal illuminating power, when the former is used in 16-c.p. incandescent lamps and the latter in ordinary flat flame burners, we have simply to multiply the price charged per unit (1,000 watts) by 10, and it gives cost of gas per 1,000 cubic feet. An Edison-Swan lamp of 16 c.p., when run at an E.M.F. of 100 volts, requires 0.60 amperes, which equals 60 watts or volt amperes—this is 3.7 watts per candle, and $1,000 \div 3.7 = 270$ candles for each 1,000 volt-amperes hours, which is the Board of Trade unit for charging consumers of electric energy.

Coal gas, when used in an ordinary burner, gives three candles per cubic foot, and thus to obtain 270 candles we should require to use 90 cubic feet of gas. Glow lamps can be worked at a higher efficiency than $3\frac{1}{2}$ watts per candle-power, but the life of the lamp is thereby shortened; we may therefore, in practice, consider 100 cubic feet of 17 candle gas equal to 1,000 watts. When are lamps are used for lighting large spaces they give an efficiency of one to two candles per watt, and are therefore considerably cheaper as regards electric energy than glow lamps, but they require attention, and are not adapted for indoor illumination unless the space is large and open.

The prices now charged by electric supply companies vary from 7d. to 8d. per unit, being equivalent to gas of from 6s. to 6s. 8d. per 1,000 cubic feet, and meter rents from 5s. to 7s. 6d. per quarter; also 7s. 6d. to 30s. per quarter for converter, main fuse, switch, etc., according to the number of lights in use. If the Corporation undertake electric lighting, I am of opinion the charge should be as follows:

10 c.p. incandescent lamps,	25s. per annum each.
16	40s.
25	62s. 6d.
50	125s.
100	250s.

In special cases the charge to be, if by meter, at 7d. per unit, which is a 1d. per unit less than the House-to-House Electric Supply Company is now charging in Kensington. I think, however, it would be advisable to charge in the first instance a definite price per lamp per quarter, for consumers will then be able to tell exactly the cost of lighting by electricity before making any alterations. Further, the cost of electricity meters are from £10 upwards, and I believe a meter well adapted for general use is yet to be invented.

The time of lighting during 12 months for indoor illumination does not exceed 1,500 hours, and the following shows the cost of a 16-c.p. gaslight, if used for this time, at the present charges for gas in Stafford:

Gas—1,500 hours $\times$ 5 c.f. = 7,500 c.f. at 3s. per 1,000 c.f. = 22s. 6d.
Electric—proposed charge for a 16 c.p. glow lamp = 40s. 0d.

The cost per annum for a 16-c.p. electric glow lamp, if charged by meter, and at 7d. per Board of Trade unit, would be, if used for 1,500 hours, about 52s.

The financial aspect of a central electric lighting station, carried out in accordance with the general outline as before briefly set forth, would be as follows:

When 1,200 (16 c.p.) lights are used, or an equal quantity of electric energy consumed during a year of 2,000 hours:

Capital of installation complete and capable of supplying 3,000 (16 c.p.) incandescent lamps as per estimate, £14,500.	£.	s.	d.
Interest on capital	£14,500 at $3\frac{1}{2}$ per cent. =	507	10 0
Renewals and depreciation	£14,500 at $7\frac{1}{2}$ " =	1,087	10 0
Working expenses, including fuel, oil, and labour, but no allowance for management		600	0 0

Total cost per annum... £2,195 0 0

Revenue, 1,200 (16 c.p.) glow lamps at 40s. each per annum

When 2,000 (16 c.p.) lights are used, or an equal quantity of electric energy:

Interest on capital	£14,500 at $3\frac{1}{2}$ per cent. =	507	10 0
Renewals and depreciation	£14,500 at $7\frac{1}{2}$ " =	1,087	10 0
Working expenses when supplying 2,000 lights, which include fuel, oil, and labour, but no allowance for management		840	0 0

Total cost per annum... £2,435 0 0

Revenue, 2,000 (16 c.p.) lamps at 40s. each per annum, or lights equal to this quantity.....

Surplus towards replacement of capital and profit... £1,565 0 0

Schedule.—Gaul-square, Gaolgate-street, Greengate-street, Bridge-street, Salter-street, Market-square and street, Eastgate-street, Martin-street, Tipping-street. JOHN FERGUSON BELL, gas engineer.

COMPANIES' MEETINGS.

ELECTRIC CONSTRUCTION CORPORATION.

The first ordinary (statutory) general meeting of the Electric Construction Corporation, Limited, was held on Friday at the offices of the Corporation, Sir Douglas Fox presiding.

The Secretary (Mr. F. Walton) having read the notice convening the meeting.

The Chairman said: Well, gentlemen, as you are well aware, this is our statutory meeting; therefore we have no report to present to you, nor are there any resolutions to be proposed; but I need hardly say that it is a great pleasure to the Directors on this, the first occasion, to be able to meet the shareholders face to face, and to exchange a few ideas with reference to the present position, and the possible future of what we believe to be a most important corporation. I may say, to begin with—it is, perhaps, a most important point—that all our capital was fully subscribed, and I don't think you could easily find a company of this size whose capital is more strongly held than ours is at this moment. Another point, which is very important, is that our works are fully occupied. We have as many orders as we can execute, and we could easily have a great many more if we could only execute them. I think, as you look at the gentlemen on my right hand and on my left, you will feel that there are practical men amongst us, and we are naturally inclined to be cautious in what we do. At the same time, our chief difficulty at this moment is that we have not room enough in our works to enable us to extend our business as we should wish. The consequence is that the first attention of your Directors has been given during the few months which have elapsed since this Company was formed to laying out very carefully, and preparing to immediately erect extensions of our works at Wolverhampton. I am glad to say that by the assistance of the gentlemen who are thoroughly well acquainted with Wolverhampton, and who have given an immense deal of time to this matter, we have been able to secure an excellent site there, with good railway and canal communication, ample not only to provide for a very large extension of our business at the present moment, but also to provide for the future. Upon that site we intend immediately to erect works which will enable us to very largely increase our output at Wolverhampton. I am very glad to tell you also that, in connection with the accumulator business of the Electrical Power Storage Company, there is a steady growth, and when we are able to combine all the business, as we intend to do, in this office, and to have all our arrangements at headquarters, you will see that that will form a most valuable adjunct to the general business of the Company. It is not very often, especially at this time of the year, that we get such a good attendance of shareholders at a statutory meeting, but we were rather anxious that our shareholders should meet us in our own offices on the first occasion, rather than that we should go to some hotel, and if the room is rather crowded perhaps you will excuse us. You will probably be aware that we are engaged at the present moment in supplying a very large quantity of plant to one of the most important companies that is supplying this metropolis. I think you will be interested to hear that Mr. Edison, who has just had an opportunity of visiting one of the installations with which we have had to do in the metropolis—namely, Rathbone-place—was pleased to say that it was the most satisfactory place he had seen during his visit here, and I am quite sure that the high character which our works director at Wolverhampton has secured to us by the excellent work he has been able to turn out will be a most important factor in the success of this Company, if only we can provide him with works large enough and with sufficient means to enable him to execute the orders which are pressing upon us on every side.

Then, with reference to provincial questions, I do not think it would be wise—and I am sure the shareholders will agree with me in

this—to mention names at the present time, because our business in that direction is somewhat in a preliminary stage. We are carrying on very active negotiations with several most important towns, both with reference to lighting, in which, I think, this Company is going to fill a very important position, as being not merely able to provide the towns with light, but to help in the financial arrangements connected with lighting. I think that is where we are going to have a very important sphere of business; and then, not only with reference to lighting, but also with reference to the application of motors to tramways. We have got several very important matters before us, and we hope that before long we shall be able to show our shareholders a practical installation of this kind, where we shall be able to run the tramways by electricity in the very successful way in which they are being run so largely in the United States. We have applications both with reference to our Julien patents and to our Sprague patents. Then I may also say that with reference to the third point to which we attach importance—that of the installation for train lighting—a very excellent example has just been carried out by the Midland Railway Company upon the Stroudley-Houghton principle, and I believe that although it is only just started, it is likely to be a very great success. The great difficulty which has arisen with reference to train installations has been how to replace the power, and I think the arrangements which are being made in connection with this train on the Midland are very likely to solve that difficulty. The great requirement for railway installations is that we should be able to light a train and be able to break it up. That has been done successfully on the Brighton Railway, but what we want is to light the train and be able to take a carriage off and shunt it on to a branch line. I don't know that I have anything more to say to you to-day gentlemen. If there is any question any shareholder would like to ask, I will endeavour to answer it to the best of my ability. Our difficulty at the present moment is simply this: that our works are quite insufficient to deal with the orders which we can secure at once, and therefore we are obliged to proceed rather cautiously; at the same time, I think we are laying the foundation of an excellent business. I may say we have secured here offices which will not be at all too large for our purpose, and we hope you will consider that they are in a good central position. And in connection with these offices we intend to have a thorough good arrangement in the base where our various manufactures will be placed, so that intending purchasers, and those in this city who intend to adopt electricity, will be able to come and see exactly what we are prepared to give them. It has been found very important to do this in connection with the Electrical Power Storage Company, from which we believe we shall secure a good deal of support. Before long we shall have a general meeting, and then we shall hope to present a regular report. In the meantime I must ask you to be content with this very lame attempt to explain to you exactly how we stand.

A Shareholder: Do we understand that in regard to each branch of the undertaking the works are in full swing?

The Chairman: They are.

A Shareholder: And doing as much work as the accommodation permits of?

The Chairman: They are doing more work than we like to have to do in their present contracted condition. We are losing no time, however, in extending the works, which is the important thing.

Dr. Drysdale: Do you expect to have some tramways running in London?

The Chairman: Well, I cannot speak about London; I spoke about provincial towns. We have several provincial towns in which there are actual arrangements being made; I would rather not mention the names at the moment, but I have no doubt before very long you will know all about them.

Dr. Drysdale: Is there no chance of London.

The Chairman: I don't know; I think it is quite possible, but I cannot speak with certainty. We hope that before long we shall not only apply ourselves to the tractive question for tramways, but to a far more important question to my mind, and that is railways. I hope that electricity will be applied in the case of railways, and if we once begin I don't know where we will end; but just now we are satisfied with the tramways.

Mr. Robert Chipperfield asked if it was true that the enormous demand far exceeded the power of supply, and if so, how it was that four at least of the concerns they had purchased paid no dividends. If that was the case, was the sum of £400,000 or £500,000 not an enormous amount to be expended in establishing such a Company as this, especially when they reflected that similar undertakings had more or less come to grief. He also wished to know on what basis the several purchase considerations were arrived at, and if the promotion money paid in purchasing the several undertakings amounted to something like £150,000. He believed the Elwell-Parker concern was the only one of the companies that paid a dividend. The prospectus stated that it paid a "substantial" dividend. It would be more satisfactory to know what the "substantial" dividend was. He wished also to know whether they had contracts for supplying light to the trains spoken of, or whether they simply obtained permission to make experiments, there being no contracts at all. He further asked what expenses they intended to incur in extending the works, and whether, when all the capital was called up, it would be sufficient to carry on all the business of the Corporation for the present without calling up the remaining £50,000.

The Chairman said the amount of capital was £500,000, of which £50,000 was taken in part payment by those who had sold their businesses to the Corporation; therefore, the actual amount issued to the public was £450,000, out of which they had called up £6 a share, and £4 a share was still uncalled, and remained as an asset to enable them to carry on their work, and to make all their payments. That amount of £500,000 left a considerable balance for working capital. He sincerely trusted that it would not prove sufficient, or

anything like sufficient, for what the Corporation would have to do. His opinion was that it was only the first instalment—if they succeeded as they expected to do—they would have to raise; but it was an ample amount for dealing with their present liabilities and providing them with working capital. There were certain questions of detail; for instance, the works at Wolverhampton, which he thought should be left over till the next ordinary meeting. They might be quite sure that the Directors would be very careful not to expend money unless they thought it was going to produce a thoroughly good result. The present need of the Company was extended works at Wolverhampton, and if they had had them now should be very lucky, because they could fill them with most profitable work immediately. He did not feel inclined to go into some of those questions which affected the original arrangements made, because all these matters were fairly put before the shareholders when the prospectus was issued. It was impossible for him to say what was paid for promotion money. What they did was to purchase the properties for a certain payment, and whether that payment included money to other people they had not the means of knowing. All he knew was the amount they were bound to pay to the vendor, Mr. Tarver, and that they meant to pay, and then he hoped they would be able to pay a good dividend on it in due course. He was told that Elwell-Parker paid dividends varying from 10 to 15 per cent.; and with reference to the other companies, he thought the point had been lost sight of by the gentlemen who had been speaking, that the great stepping-stone to success in this Company was the amalgamation of these different interests. He did not think these companies, standing by themselves, would be worth what the Corporation was paying for them; but the point was this: they were amalgamating those interests, and forming a strong buttress against opposition, and the patents which they held became extremely valuable.

Sir Daniel Cooper, Bart., said he had had to do with the railway lighting for the last five or six years, and he might state that all the contracts for lighting the different railways were written contracts. They had to give them 12 or 18 months at a certain price, so that the officials could judge for themselves whether the companies ought to take the lighting up or not. The officials wanted to be certain that they had got a good thing, and as the Directors knew it was a good thing, they gave them all the facilities they could, and that was the only way he thought to promote the business of the Company. He belonged to one of the companies whose business had been purchased by this Corporation, and he knew they had got a good bargain. He did not see how, if the Corporation was carried on with skill, and with a proper board of Directors, it could not fail to be a great success.

Mr. George Dibley then proposed a vote of thanks to the Chairman for presiding.

Mr. Chipperfield seconded the motion, which was unanimously agreed to.

The Chairman having acknowledged the compliment, the proceedings terminated.

DIRECT SPANISH TELEGRAPH COMPANY, LIMITED.

The twenty-third ordinary general meeting of this Company was held on Tuesday at Winchester House, Old Broad-street.

Sir James Anderson presided, and in moving the adoption of the report said he thought it would be considered fairly satisfactory on the whole. There had been an increase of £508 in the traffic receipts, while the expenses showed a slight decrease. During the half-year they had had an interruption of 16 days in the Bilbao cable, but, fortunately, they had a joint-purse agreement with the Eastern Telegraph Company, and the losses by such interruptions were never very serious. Their revenue, he was glad to say, was mainly due to commerce, the traffic not having been benefited by any political disturbance. A few years ago many towns which now had a very free intercourse with Spain by telegraph never used the wires, and therefore he supposed they then had no trade with Spain. We were, however, led to believe that the trade of our country had increased with Spain, and certainly the Company now received telegrams from the great manufacturing towns which were quite new to them within the last two or three years. Last month alone they had an increase of 2,920 telegrams, or 31,200 words in excess of the number transmitted in September last year, and for the past quarter their receipts had been £381 in excess of those of the same period of last year, notwithstanding their low tariff—4½d. a word. They delivered messages in Bilbao under 10 minutes—very often in five minutes—and in Madrid they were delivered a good deal within the hour—in three-quarters of an hour, he understood. All telegraphic service depended first on accuracy and then on speed, and they were increasing the speed as far as possible, getting better wires from Barcelona and Bilbao to Madrid. So far as Madrid was concerned they had very little to complain of, but still there was room for improvement. The reduction in the length of the messages had been going on at the rate of nearly a word every year, and he scarcely knew where the process was going to stop. He, however, did all he could to persuade himself—he hoped correctly—that though the length of the messages decreased their number increased. Last year and the year before he told them that though they had carried more messages they had received less money, but that feature had disappeared this year, for they had both carried more messages and made more money. The removal to larger offices and the consequent alterations had cost them £600, which they proposed gradually to pay for out of revenue.

Mr. Edmund Etlinger seconded the motion, which was adopted, and a resolution was afterwards passed declaring dividends for the half-year at the rates of 10 and 5 per cent. per annum respectively on the preference and ordinary shares.

THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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IMPORTANT NOTICE.

We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No paper that we know ever refuses Subscribers or Advertisers. Nor do we; in fact, we invite them, believing that they will get full value for their money.

Specimen copies of the paper will be sent on request.

TOPICS OF THE MOMENT.

Readers of "Noctes Ambrosianæ" are nowadays few and far between, but probably a good dose of the Ettrick Shepherd would enable many men to express their opinions upon the topics of the day more forcibly, if not more easily. In another column we give a report of the statutory meeting of the Electric Construction Corporation, a perusal of which will show that chairmen have much to learn, except, perhaps, it be the art of manipulating shareholders. Unfortunately, in the concern under discussion, the real information required to determine the value of the business taken over cannot be given. As the chairman said, the company paid a certain price for what it purchased, and whether the price so paid included a hundred thousand or so to the promoters, the books of the company would not show. What a bore these shareholders are who insist upon asking irrelevant questions, that is, irrelevant so far as the directors and the chairman think. Indeed, the latter might well have a stock paragraph of the Ettrick Shepherd at hand wherewith to answer the insisters. What would be better than: "Weel, weel, sir. I never insist. Oh! hoo I hate to hear a hash insist! Insistin' that you shall tell a story . . . insistin', in short, that you shall do the verra thing, whatever it happen to be, that ye hae declared a dizzen times that you will be dang'd if you do do—dang him! droon him! deevil droon him! canna he haud his foul tongue, and scart his saut head without ony interruption, and be thankfu—" yea, and be thankfu—that the said chairman and directors have taken in hand the spending of his money, the purchase of his concern about which he is to get but meagre information. It would be difficult to string together more unmitigated twaddle than was offered as pabulum to the shareholders of the Construction Corporation the other day. Let us take one point only, put forward to make the shareholders believe that some wonderful card was held up the sleeve. "We hope," said the chairman, "that before long we shall not only apply ourselves to the tractive question for tramways, but to a far more important question to my mind, and that is railways." Now we are willing to prophesy that among all the men who have a fair knowledge of electrical engineering there are not a dozen to be found foolish enough to argue that there is within sight any possibility of applying electric traction to ordinary railway work. We do not mean to say that there are not exceptional lines where electric traction may not be expedient, but we say its application to the ordinary railway system of the country is, according to our present knowledge, an absolute impossibility, and no one not a candidate for Hanwell would suggest it. The future may have many surprises in store, but a set of directors have to work upon present and not future possibilities.

Their work is on present lines for present profits, and shareholders will not be put off with possible dividends in the millenium. A lot of rubbish has been talked about the application of electric traction to railways. We have been told the whole paraphernalia of railway structure, lines, bridges and all, would cost less, could be less substantial, and so money saved in a dozen ways. Rubbish. Our lines are built, and we are not going to pull down existing lines on purpose to build others at less expense. But more, there is not an atom of truth in this theory. The lines would have to be just as substantial, and hence there would be no saving in that direction. Then, again, engineers require to be convinced that the insertion of other pieces of apparatus between the prime motor and the load leads to economy. They imagine that to increase apparatus tends to loss, and that no saving would be effected by the use of stationary engines, dynamos, motors, and mains, and for our part we have neither facts nor figures to convince them to the contrary. If there was the remotest chance of work in this direction in the immediate future, we should be the first to applaud the spirit that led directors to contemplate such action. It may be argued on the part of these directors that the references made and the ideas held by them are to utilise secondary batteries for railway work, and for this purpose they have obtained the business of the E. P. S. Company and the control of the Julien patents. If such is their argument their case is far worse than we imagined, and Sir Daniel Cooper's remarks may have a subtler meaning than at first sight appears. He is reported to have said, "if the corporation was carried on with skill, and *with a proper board* of directors, it could not fail to be a great success." Now we do know that connected with this concern are some of the keenest business men of the country, and certain directors that would be able to make a dividend where other more ordinary mortals would utterly fail to stave off a loss. Gratuitous advice is never relished, but the plain course of this company seems to us to be to develop and extend their manufactures. The demand for secondary batteries is large and increasing. The apparatus can be designed for many purposes for which, at present, it is not in demand. In this manufacture there is money, and this the directors want if they are to pay dividends upon their large capital, large we mean in comparison to what it ought to have been had there been no squandering of money through a clique of promoters. It is useless for them to risk the shareholders' money upon schemes which have no present chance of ensuring a return, and they will find a blank wall if, for some time to come, they attempt to issue any new capital. We know that this was the original intention. We also know that the men who pulled

the strings have not yet unloaded at a profit, and we do not intend that they shall. The duty of the directors is, in the first place, to show that they constitute what Sir D. Cooper called "a proper board." We have spoken of one branch of their business in which "money" is to be made, but they have another probably equally lucrative manufacture in the engineering business, more widely known as Elwell-Parker. It will be heart-breaking work for the managers of these two businesses if their profits are squandered by the directors in the prosecution of such schemes as those alluded to by the chairman.

Another important point for the consideration of shareholders is in the chairman's remark, that they were going to fill a very "important position, as being not merely able to provide towns with light, *but to help in the financial arrangements connected with lighting.*" We prefer not to comment upon this statement at any length just at present, but if it means anything it means that the directors hope to make money by "company-mongering." That is not sound business, and the people outside the promoting ring who have invested their money in a "construction" company may not feel so easy in mind when the concern is embarked upon the quicksands of speculation. One thing we have continually to remind shareholders—it is that those in the swim seldom lose much: it is those who blindly trust that pay the piper.

ELECTRICAL MANAGERS.

With the extension of electrical industries the want of competent managers for commercial undertakings that owe their existence to electricity becomes more and more apparent. The demand for competent business managers as such does not exceed the supply, in fact, as in other kinds of labour, the excess is on the side of supply. But the question really is, or should be, what are the qualifications of a competent manager of a scientific undertaking? The applicant for the position of manager of any other business is always expected to have a knowledge of the business he is to manage, without which he would be unfitted for his post.

Why should this not be the case in scientific as well as in other enterprises? Those who have had any experience, either in the capacity of engineer or of manager, will not gainsay the fact that the acquisition of the services of a man as manager who combines technical with financial ability would not only dispense with the employment of his representative in technical matters, but would simplify matters to an enormous extent, and would inevitably effect a considerable saving in expenditure, due to what may be termed mismanagement. This mismanagement may not be due to inability on the part of the financial or technical staff, but it follows that one man who can grasp both phases of a question is better able to deal with it than two men who do not fully appreciate the difficulties of more than one side. The saving consequent upon the employment of such a man would be incalculable to a company in course of formation; that is to say, a company really fully fledged, but not settled down into business-like habits.

It is a fairly patent fact to all that in the early stages of a company's existence a great deal of money is thrown away through lack of that proper supervision and system without which mismanagement, delay, and extravagance are inevitable. Certainly the workmen know it, and it is a common saying that, for making money, there is nothing like a new company. Directors know this from bitter experience, and most shareholders have realised the fact, and are quite alive to the advantages that would accrue from placing the management of their property in the hands of a man who is competent to direct it both technically and financially.

Sir William Thomson impressed upon rising members of the profession, in his inaugural address to the Institute of Electrical Engineers, that it was not only wise but necessary for an electrical engineer to become first an engineer and afterwards to study electricity, because in this way he would not only be better able to grasp the subject, but would be far more capable of dealing with it in practical work. For a man to become useful as an electrical manager, he should acquire his technical knowledge and experiences as suggested by Sir William Thomson, and after this devote himself to the theory and practice of management. Engineering, electrical or otherwise, is after all nothing more or less than a branch of commerce except to a few, and such being the case the advisability of becoming acquainted with business matters is obvious; if for no other reasons, because a young engineer with any common-sense at all is always capable of carrying out his chief's instructions, and the salary of such men (of whom there are already thousands, and whose name is, or soon will be, at the present rate of increase, Legion), would not be more than £200 to £300 a year. His superior in the person of our ideal manager would be receiving from £800 a year upwards, and his services would be worth fully that figure, at least, to a company of reasonable proportions. Small undertakings, of course, must be content to act simply as training schools to men with any ambition, as the salaries they can afford to pay must necessarily be small in proportion to the field of operations.

In the struggle for supremacy in that path of life which a man chooses, the first thing he should do is to make up his mind as far as possible as to the direction and extent of his capabilities. Many men who have started life as engineers are practically useless as such to themselves, for the simple reason that though they may be fairly good men in their way, there are very many others better gifted, against whom they will never be able to combat. These same men, on the other hand, might make excellent technical managers, and know quite enough of engineering and electricity to render their insight into the affairs of an electrical undertaking very much greater, and the services proportionately more valuable to their employers than would be the case if they had no technical knowledge.

The career of such a man in the rôle of a man of science must necessarily cease to a certain extent, but it is every man's duty to make his way in the world, and that man would be acting wrongly in the development of his own usefulness by continuing a purely scientific career if he feels he cannot rise to the top of the tree, or at all events to the upper branches.

PARIS EXHIBITION.

We give below a list of the awards to electrical or electrical engineering exhibitors, made at the Paris Exhibition. It must be remembered that, as a whole, England was poorly represented by those engaged in this particular industry, hence many of the names that might have been expected will not be found in this list.

	Cl. No.	Award.
Acme Electric Works	62	H. M.
Alliance Aluminium Company, Limited	41	G.
Aluminium Company	41	G.
Automatic Electrical Corporation, Limited	62	B.
Clark, Muirhead and Co., Latimer	62	G.
Crompton and Co., Limited	62	G.
Crossley Bros., Limited	52	G.
Davey, Paxman, and Co.	48	G.
" "	49	S.
" "	52	G.
Davis and Timmins, Limited	41	B.
" "	62	B.
Denny and Co.	65	G.
Eastern Telegraph Company, Limited	62	G.
Electrical Power Storage Company, Limited ...	62	S.
Elliott Bros.	62	G. P.
" "	65	S.
Elliott, Samuel	63	S.
Globe Electrical and Engineering Company	62	H. M.
Greenwood and Batley, Limited	53	G.
Henley's Telegraph Works Co., Limited, W.T.	62	S.
Paterson and Cooper	62	S.
Timmis, Illius A.	61	S.

G. P., Grand Prize; G., Gold Medal; S., Silver; B., Bronze; H. M., Honourable Mention.

Errata.—In our leader on the Bradford Corporation electric light station, by a printer's error the rate to be charged was mentioned as five shillings per unit, instead of fivepence, as our technical readers will at once have understood.

DISTRIBUTION OF ELECTRICITY IN CHELSEA, ETC., WITH ACCUMULATORS AS THE MAIN SOURCE OF SUPPLY.*

BY MAJOR-GENERAL WEBBER, C.B.

Accumulation of electricity is the first necessity to those who study the conditions of its supply to consumers living in a thickly-peopled district, and has been so since the notion of distribution to an inhabited area from a centre of generation has taken a practical form.

In face of the many cases in which distribution has been undertaken without accumulation, this may be regarded as a bold statement. But I can only say that I have not met one who, having adopted it, does not candidly admit that the advantages of the presence of means of accumulation are undeniable.

The financial question has governed the advance of the industry, and the scattered nature of the first demands for a supply of electricity has, without doubt, led to the adoption of high-pressure distribution when every other consideration would have appeared to suggest that all first attempts should have been made at low pressure.

The insulation afforded by the use of aerial conductors has led to partial success. If the distribution had had to be carried out by underground mains from the first, the deterrent effects of the experience that would then have had to be gained might have led to different procedure, and even the financial aspect of the question might have gone through different phases.

Some will assert that the industry in this country could not have made a start at all, in the face of cheap lighting gas, if it had not been pioneered by means of economical conductors, however temporary, and without attempting to accumulate.

But, after all, it was only a question of cost, and it is certain that had the capital been forthcoming in 1886, it would have been as easy to have obtained success with the system I am about to describe as now. All the essential means now at our disposal, except matters of minor detail, were then equally at hand.

This is proved by the fact that the proposals prepared and made in 1886, immediately after the Chelsea Provisional Order was approved by Parliament, are similar to those which have been carried out in 1889. It was as clear then that accumulation and distribution underground was the true solution of the problem for a comparatively densely-populated district.

The district of Chelsea was selected, not as the wealthiest or most densely populated, but because it was destined then, and since then, and for some time to come, to be one in which the dwellings are in a process of reconstruction. It was in 1886 as evident as it is now that the impediments in the way of getting old houses wired is a serious hindrance to the rapid spread of the demand for current, and that this impediment is minimised under that condition.

In the interval many of us have been fascinated by the high-pressure systems. I think myself fortunate that, I may say, accident prevented me attaching myself to any scheme dependent on that condition, together with alternating currents, for domestic supply.

The temptation was rather strong for one reason at least—that is, that some capital was forthcoming to promote the latter, while very little could be got together to carry out the former plan. Although it is not sound, the Engineer sometimes *does* surrender his better judgment when money leads.

The Chelsea system may be described in the following terms: Accumulation of the main supply from a generating station in storage stations, situated at suitable distances from one another, combined with the following:

(a) Charging the accumulators at high pressure, and discharging for distribution at low pressure, and effecting the changes necessary to the same by special automatic arrangements placed in each storage station.

(b) Supplementing the main supply by means of continuous-current transformers.

(c) Distributing by means of mains laid down in a network.

(d) Maintaining a constant pressure by means of the introduction into the discharge circuit of counter E.M.F. cells, and by means of feeding points judiciously placed intermediate between the storage stations.

(e) The use of underground conductors throughout, laid so that the cables can be drawn in and out, and renewed or repaired whenever necessary, without disturbing the ground.

It has been remarked that one of the causes of interference with the spread of the use of electric light is the outlay entailed by the necessity to introduce conductors and fittings for distribution and consumption within the house.

Members of a society called the Dynamicables will remember a paper on this subject, read a few years ago by Mr. Crompton, when he expressed a hope that the cost of such work might be brought down to 15s., without including the lamps and their fittings, for each point where the light is required.

The fact that this figure has rarely been realised, and more often doubled, is not, however, the chief impediment. It has been suggested that the undertakers might carry out the work on a deferred payment system, but this would meet only a limited number of cases. The main cause of impediment at present is the condition of the situation as regards landlord and tenant, by which there is no inducement to the former to do more for his tenant than his lease obliges him to do, and by which there is no compensation to an outgoing tenant for outlay on *bona fide* improvements.

The fitting up of houses for gas consumption has now, by competi-

* Paper read before Section G of the British Association at Newcastle September, 1889.

tion, been brought down to about 7s. for each point where a burner has to be fixed, above a certain minimum number of points.

Except under Government Departments, I have rarely encountered any form of specification for such work. I have never yet heard of gas engineers being called in to advise on or pass work for the distribution and consumption of gas inside buildings, beyond questions of meterage and regulation of pressure.

The consequence is that the proportion of gas, which from one cause or another escapes unburnt, and enters into combination with the air we breathe, is very considerable in proportion with the gas we actually use to give us light, varying from 1 or 2 to 7 or 8 per cent., some due to defects in pipes, more to defective burners.

For economy, the same work in connection with electric lighting is rapidly tending to fall into a similar condition, and were it not for the practical necessity to take precautions to protect buildings from fire risk, and the public from injury to person, which has given rise to Fire Insurance and Board of Trade rules, the consumers of electric current ere long would find themselves in a worse condition than if they stuck to gas as an illuminant for reasons in connection with leakage which are evident to all my hearers without any description.

In Chelsea we have from the first endeavoured to counteract this evil by

First. Holding aloof from all appearance of having any pecuniary interest in the work of fitting up houses in the area of supply.

Second. Supplying to the inhabitants, either free of cost or for a small fee, a copy of our standard specification for such work. This form is compiled so that it can be used under varying conditions when filled in by a competent engineer. A sample of it is attached to this communication.

The necessity for care and precaution in this respect, and the consequence of a little more trouble and expenditure to the public, than has hitherto been given to the subject of lighting, is, however, well repaid by the advantages to health and comfort by adopting electricity as an illuminant.

This is the sole lever with which electric light undertakers have to work in face of—

1. Competition with cheaper illuminants, which in the case of mineral oils are one-third to one-fourth the price of electricity, light for light, both as regards first and annual cost.

2. Indifference to the question of health so long as the danger is not very apparent, only being very slowly counteracted by the spread of knowledge.

3. Rules and regulations which everyone acknowledges to be salutary, but which must hamper the industry at first, particularly so, as the rival illuminants are not subject to anything of a similar kind.

The apostles of electricity as an illuminant have, however, no fear that sooner or later it must triumph, and that the poor as well as the rich will eventually enjoy its advantages; and that those who have given labour and attention of the most exceptional nature to produce perfection will eventually reap their reward.

Leaving this branch of the subject of consumption, it should be stated, *en route*, that the meters in use in Chelsea are those of Aron, Chamberlain and Hookham, and of the Brush Company.

The first which is used in this country under a royalty from Messrs. Ayrton and Perry, and which is at present in a large majority, has undergone considerable modification and improvement in construction lately with the result of greatly simplifying its action.

The meter as now employed has no starting gear as formerly, to which objection had been found to exist.

The meter is compact, being about 2ft. 5in. long by 15in. wide and 8in. deep. It is constructed of two sets of clockwork, the deviations of which are to be indicated, mounted side by side in the same frame with a differential counter placed between the two sets of clockwork. The clockwork is driven by a spring. The differential counter consists of two crown wheels, having at the same time a cylindrical gear opposite each other. Between the crown wheels a planet wheel is arranged gearing with both the crown wheels, and is made so as to turn at the same time round its own centre, and so as to roll along the cylindrical gear of the crown wheels, and it is balanced by a counter-weight.

The vibrations of the pendulum of one of the sets of clockwork is either accelerated or slackened by the influence of a coil through which the whole of the supply current passes; the pendulum has a permanent magnet or armature attached to its end, and is so arranged as to swing immediately over the centre of the coil.

The clockwork being synchronised, there is no movement of the indices on the dials when no electric current is passing, although the clockwork is running continuously.

The clockwork runs for six weeks, but we find it advisable to wind them once every month to ensure them from accidental running down before their time, and thus stopping their use for registering.

They are easily fixed in position by a workman. It is only necessary that care should be taken to set the pendulums so that they hang immediately over the setting pin placed for the purpose.

The man then winds the meter, starts the pendulums swinging, and the meter is then ready for work and for the purpose of recording when the electric supply is started.

These meters have given most satisfactory results during the six months we have had them in use.

The meter registers in ampere-hours, *i.e.*, each unit registered by the index dial has to be multiplied by a constant supplied with each instrument.

For the convenience of customers, a multiplier is supplied by us with each meter card, and instructions printed stating that the amount registered by the indices at any time multiplied by the multiplier given on the card enables them to ascertain in Board of Trade units the consumption of current.

The meter of Messrs. Chamberlain and Hookham has been so thoroughly described this year by Mr. Hookham before the Institu-

tion of Electrical Engineers, that I need not give any of its details. Our experience of its working is at present very limited.

The Brush Company's meter may be described as follows:

The meter consists of (a) an electrically driven pendulum, suspended over an electromagnet (a_1), but slightly at one side of it.

Near the pendulum is placed, vertically, a solenoid (b) in circuit with one of the conductors to the lamps; the core is carried by a light rod attached to a spiral spring suspended from above. To the side of the rod towards the pendulum is fixed, in the plane of oscillation, a notched integrating plate (c). As the core is drawn down by the current passing through the solenoid, or lifted up again by the spring, the notched plate is also raised and lowered.

An horizontal arm (d), resting on two rollers, travels backwards and forwards with the movement of the pendulum, but the distance travelled, or amplitude, is controlled by the notched plate, being greatest when the core is drawn down so that the horizontal arm travels as far as the uppermost notch, and smallest when the core is elevated so that the arm is stopped by the notch on the edge of the widest part of the plate.

The arm carries a small catch, which, when it travels to the left, drawn thither by the spiral spring at that end, pushes round the last and lowest wheel of the counting gear (f). For instance, when the arm moves through the shortest distance the wheel is pushed round only one notch.

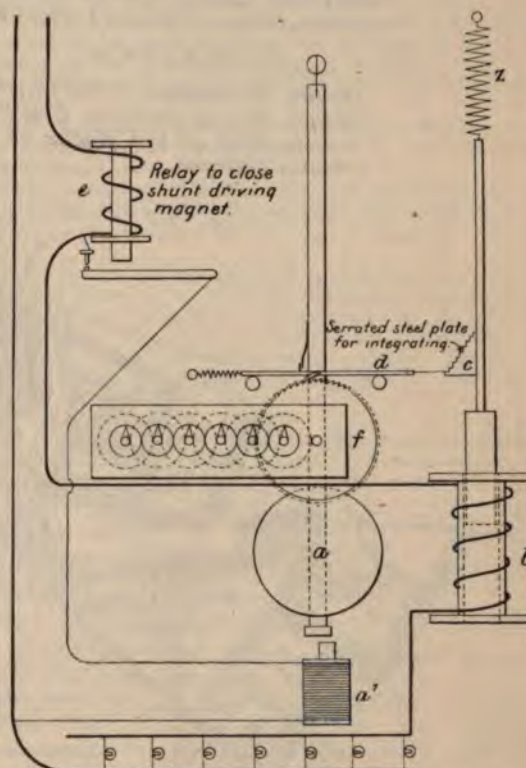


Diagram of Brush Company's Meter used at Chelsea.

This smallest movement may be regulated to occur when one-third of an ampere is passing through the solenoid, and thus accurate metering is ensured by the construction of the parts being such that for each sway of the pendulum the last wheel of the gear is always advanced through an angle exactly proportional to the current flowing at the moment.

The electromagnet (a_1) used for driving the pendulum is on a shunt from the supply main, the circuit of which is closed and opened by a relay (e), which comes into action with the smallest current that the meter is required to measure.

I have described the main features of this apparatus only, but there are other minor ones; for instance, a contact-making device worked by the pendulum for the purpose of properly timing the impulses given to the electromagnet (a_1), with which I will not occupy the meeting.

A marked feature in the system of distribution by continuous current at low pressure is the absence of the transformer from the premises of customers, and the small space required in the house for the meter and cut-outs. Although the space required for a transformer is not theoretically large, in practice it is found that its installation is a more serious cause of expenditure and interference with structure than the advocates of its use lead us to suppose. In very few houses is to be found a chamber suitable to receive a transformer of ordinary size. In 1887 I inspected one of the first installations under the system, namely, at Lucerne, by Ganz and Co. There I found the transformers in cupboards, and heating so as to colour the surrounding woodwork. The insurance companies in England would not have permitted them to remain in such a place. It is wrong to suggest that the installation of a transformer does not entail an expenditure much in excess of its actual cost. This condition affects materially the comparison between the first cost of rival systems.

We now come to the work outside the customers' premises, and I am able to show you a diagram illustrative of this part of the distribution.

The area comprises portions of the parishes of Chelsea and Kensington. Its superficies contain about 867,000 square yards, or about $1\frac{1}{3}$ of a square mile.

This area, divided into storage areas, in each of which a storage station is, or being, placed, allows to each such sub-area a space represented by a square of 415 yards a side.

The generating station is marked (X), and in the same building is placed a storage station. The other storage stations are marked O. Of these there are five in all.

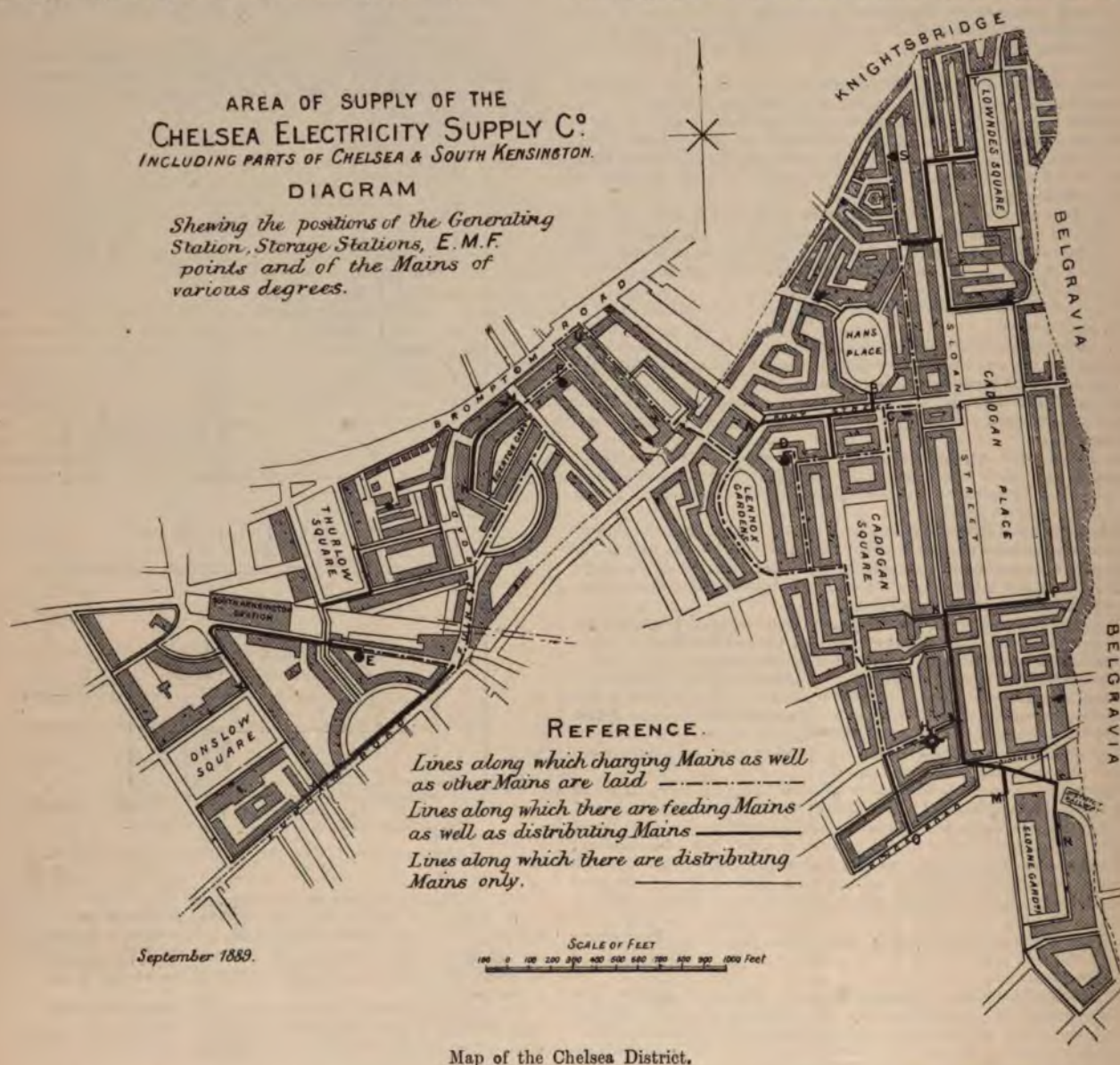
The points to which feeders are taken are each marked +, with letters to most of them. Each storage station itself is also a feeding or E.M.F. point. At present, the feeders vary in section between 61/12 and 37/13, according to the length and the current it is estimated they will be called on to conduct.

The distributing mains, which are laid so as to supply the houses in every street prescribed by the Act as compulsory, sometimes in front and in some places at the back, connect all the E.M.F. or feeding points, and vary in sections between 37/13 and 19/16.

After careful consideration of the subject from all aspects, the use of bare copper conductors was discarded. With the permission of the War Office, experiments had been made by me at Pimlico with bare copper conductors so long ago as 1884. In making the tests I had the kind assistance of Prof. Ayrton, F.R.S. The conductors were made of uncovered copper wire cables, I think 19/12. They laid in notches made in insulate saddles seated in cast-iron troughing 6ft. long, jointed end to end, and having covers also carefully jointed; the cables were free of all approach to contact with the surrounding iron, and all the joints of the iron casing were watertight, or believed to be so. Tests were made with a 50 ampere current at an E.M.F. of 80 volts at intervals of some months after the wire was laid underground, and it was tested under the two conditions of having the intervals around the cables left vacant, and filled in with paraffin wax.

The results led to the complete abandonment of the plan, and of the patent which had been taken out for it.

There is a strong resemblance between it and the mains which are being now laid down in the district in London known as the St.



The pilot wires from the storage stations to the generating stations, and from the E.M.F. points to the regulators in the storage stations, are of small section, and have their separate "ways" in the conduits or cases.

All the "ways" can receive cables of larger dimensions, so that the section, when necessary, can be increased. And besides in each line of conduits spare "ways" are provided for future use.

Up to the present time, about 10,575 yards of cable have been drawn in and put to use, besides some thousands of yards of pilot wires. By the end of this year these figures will be increased more than half as much again.

The joints in the E.M.F. boxes, between the feeders and the distributing systems, are made by soldering the cables to a copper jointing piece, made as shown in the diagrams on the blackboard.

All cables, after being drawn in and before being jointed, must show an infinity insulation resistance test before being passed. The test is made at a pressure of 100 volts. In many instances, after joining up sections of the network, and testing them together, including joints of house services, the disconnected ends sealed, the same result has been obtained.

The question of the cost of the mains and house connections is one which forms a most important factor in the undertaking.

James's. For the sake of the industry, in which so many are interested, I trust that those responsible for that work will meet with greater success than I did.

Experiments were made in 1886 and 1887 with the view to obtain some form of conduit which afforded a separate "way" for each insulated flexible cable; and so that the old and well-known drawing in and out system of the Electric and International Telegraph Company, founded on an experience of many years, might be followed.

A metal tube for each cable was too costly. The bundle of cables in one iron pipe would prevent the possibility of drawing in and out.

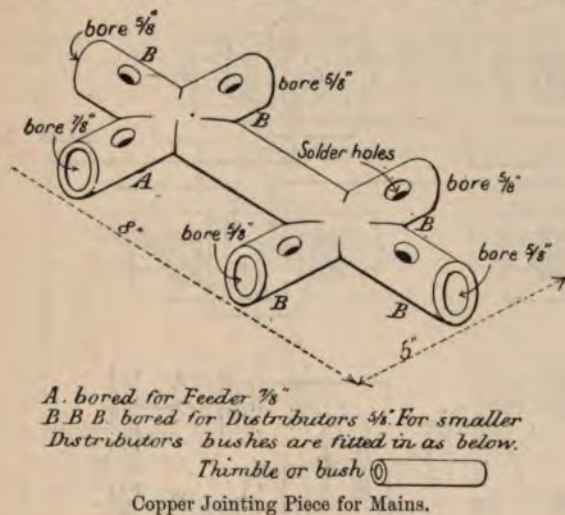
The material of bitumen concrete, which could be moulded to any form, presented itself, and the patent of Butler as to the mixture was followed. The Callender Bitumen Company undertook to carry out the work, and a sample line of casing and cable drawn in was laid, and was under trial during the period of one year at the Borough-road premises of the Anglo-American Brush Electric Light Corporation.

Out of this has grown what has become known as the Callender Webber system, descriptions of which have been given elsewhere. All that was anticipated of its advantages have been more than realised in Chelsea.

Although the part of Chelsea in which operations were carried on should present the fewest difficulties to be encountered in any part of

London, it was found that there was little or no local knowledge as to the size or position of the cellars of houses, and that no one could tell where the arches stood, or where the water and gas mains and services actually lay.

As the access to house service boxes must be easier if the main is in the footway than if it is in the roadway, every effort was made to keep within the edge of the kerb. But to do this in many places was found at first to be impossible, and the cases had, in several places, to



be laid under the roadway. In such a position it was necessary to keep them outside the gas and water mains, and as the local authority prescribes a minimum distance of 3½ ft. between these mains and the kerb, and 1½ ft. between mains themselves, it followed that those for the electric light had to be 8 ft. or 9 ft. from the kerb.

The future inconveniences arising from this are so many that it has now been decided never to lay the "cases" anywhere under the roadways, except at crossings, unless absolutely physically impossible to do so.

ditions vary at every point, so that brick in cement for all these boxes is the best material.

A specification of the manner of conducting the work is in use, and a copy of it is attached to this communication.

If care and attention is given to the simple rules for laying the casing, no difficulty is encountered with the cables. A true and smooth way is provided for each, so much so that in rare cases of need from one cause or another no difficulty has been found in pushing through from box to box one of those screw-jointed rods used by sewer men or chimney sweeps.

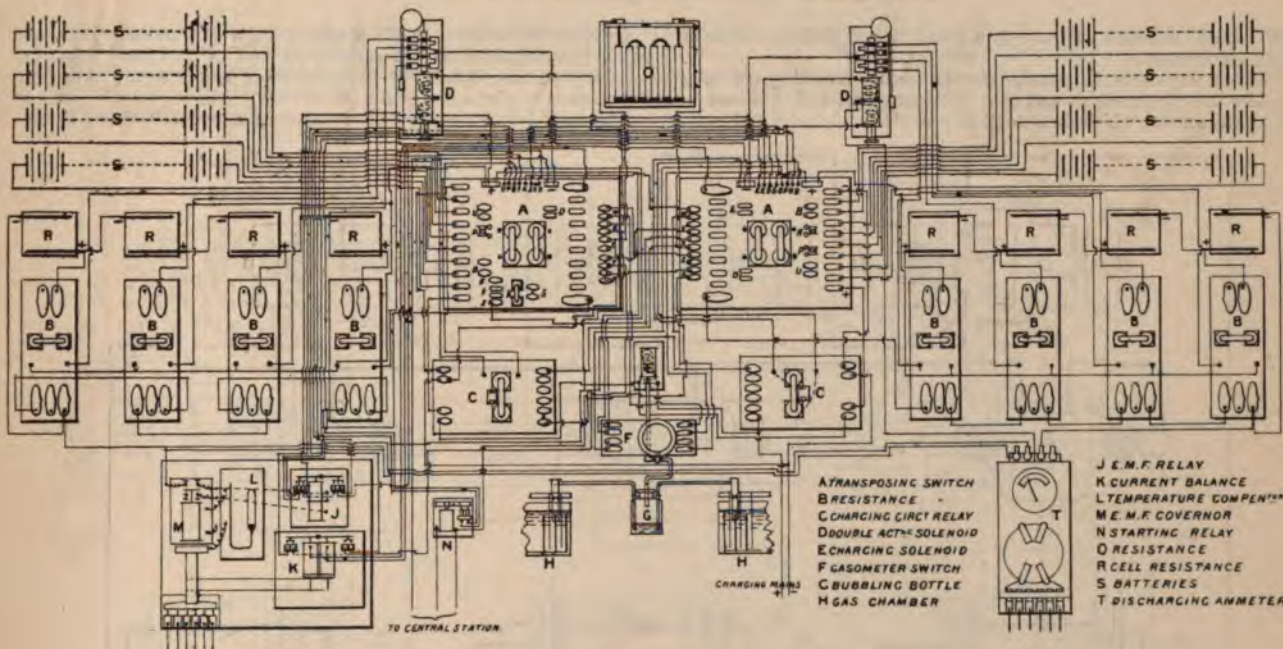
It will be gathered from the features of the system I have referred to that considerable economy in excavation can be secured by its adoption, in actual cost of the "ways" for the cables, totally avoiding the need for special castings for bends, and also in all the operations of branching-off and jointing. In comparison with the bare copper systems, the saving in towns in the cost of removing the soil to make space for the conduits is very considerable. Of the durability of the material, resistance to strains, and conditions of temperature, so far the proofs have been very satisfactory.

But, as I have already stated, its foremost advantage is that it enables us to comply with the fundamental conditions of successful maintenance by permitting the easy and rapid removal of faulty sections of cable, and the renewal of the same. Under such circumstances, with low-pressure distribution, a high standard of insulation resistance may be dispensed with, and a further saving in outlay effected. For let it be remembered that failures of the insulation of underground distributors of electricity will not occur by the gradual deterioration of the dielectric throughout its length, but by the existence of exceptional causes for its decay at isolated and unexpected points.

Although the substance of which the Callender-Webber casing is made is dielectric, yet no reliance is placed on it even as an assistant to the insulation.

The slight porosity of the material, and the impossibility of making an absolutely watertight joint at every point where the lengths are united, at present precludes the idea of complete exclusion of moisture.

It will be seen that this system lends itself to the manner of distribution already described, by bringing within the range of practical expenditure the provision of the necessary number of "ways" for charging, feeding, and distributing mains, all of which along the same route may be lying contiguous to one another. The reference to it forms part of the description, leading up to an examination of



Automatic Regulator of the Electrical Power Storage Company, as employed at the Chelsea Sub-Stations.

The material of which the "cases" are made lends itself to this, as it can be made in flat sections, with a single tier of holes, and in such a form occupies very little space in depth. The facility of bending it is also a great aid in passing obstacles.

There have been instances in which we have been able to get in "casing" in advance of the services of the gas and water companies, and in those we calculate that the cost is reduced at least 10 per cent.

The great ease with which the material of which the casing is made can be cut, simplifies the operation of inserting a house service box on the mains that have been previously laid. Only that portion of the case need be removed which contains the ways in which lie the distributing mains. The box is best formed of brick in cement, and the top of cast iron, with a waterproof cover flush with the footway.

The same manner of construction has been found best for draw-boxes, the iron tops of which are either L or T shape, also the E. M. F. boxes, where the feeders terminate. In the latter case the ordinary street manhole cast-iron top has been found to answer very well the purposes of a cover.

Practice shows that if the sides and bottoms of the box were also made of iron, a great variety of patterns would be required, as the con-

ditions of the system of distribution, in which accumulation constitutes the chief source of supply, and not a mere auxiliary.

In such a system the generating station is even subordinate to the storage stations.

Given an area, and having determined what may be called (1) the active demand, and (2) the possible ultimate demand, and having decided to provide for the first, with the power to meet the second at some future date, the first thing is to lay it out in storage districts, always subject to the power of securing sites, and next, to fix the positions of the points to which feeders should be carried. This would be a difficult thing were it not for the elasticity afforded by the network system, and by the power of varying the section of copper in the mains, which is simplified by the use of "ways."

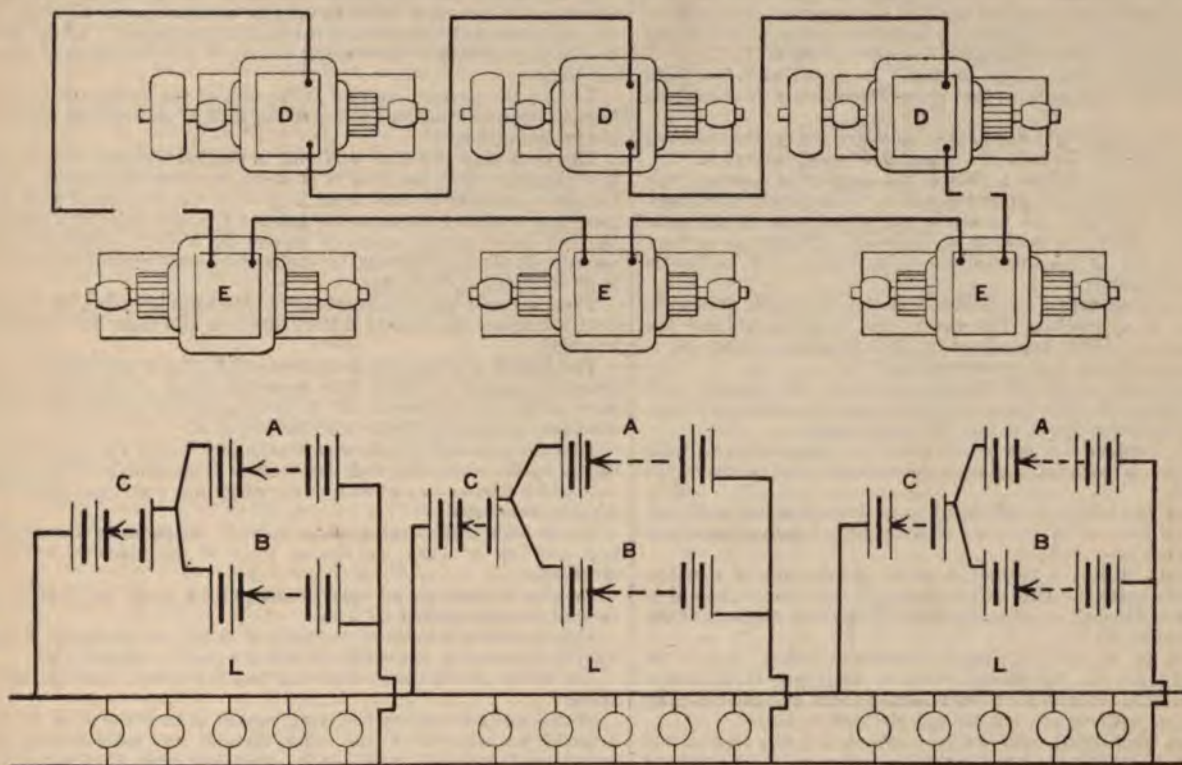
Our estimate in Chelsea to meet the "active demand" has been to establish one storage station to each 210 shops or residences, and to provide capacity for 27 30-watt lamps being in use at one time in one-third, or 70 of these. The distribution being at a pressure of 100 volts in the distributing mains, or 106 to 108 volts in the feeders at the station, a discharge of 600 amperes to give 530 effective at the lamps, allows an ample margin, and this is afforded by the two half batteries in each storage station discharging at the same time. Each

The diagrams on the wall represent:

First, three of these plants in series charging one of the half batteries in each of three storage stations, the lighting being maintained by the other, or second half, battery; and the pressure in the distributing mains being regulated by cells which give a counter E.M.F.

The movable portions are worked by the energy which would otherwise be wasted in the counter E.M.F. cells, which are used for regulating the pressure in the distribution system.

All the actuating portions of the apparatus require current at an E.M.F. of only four or five volts.



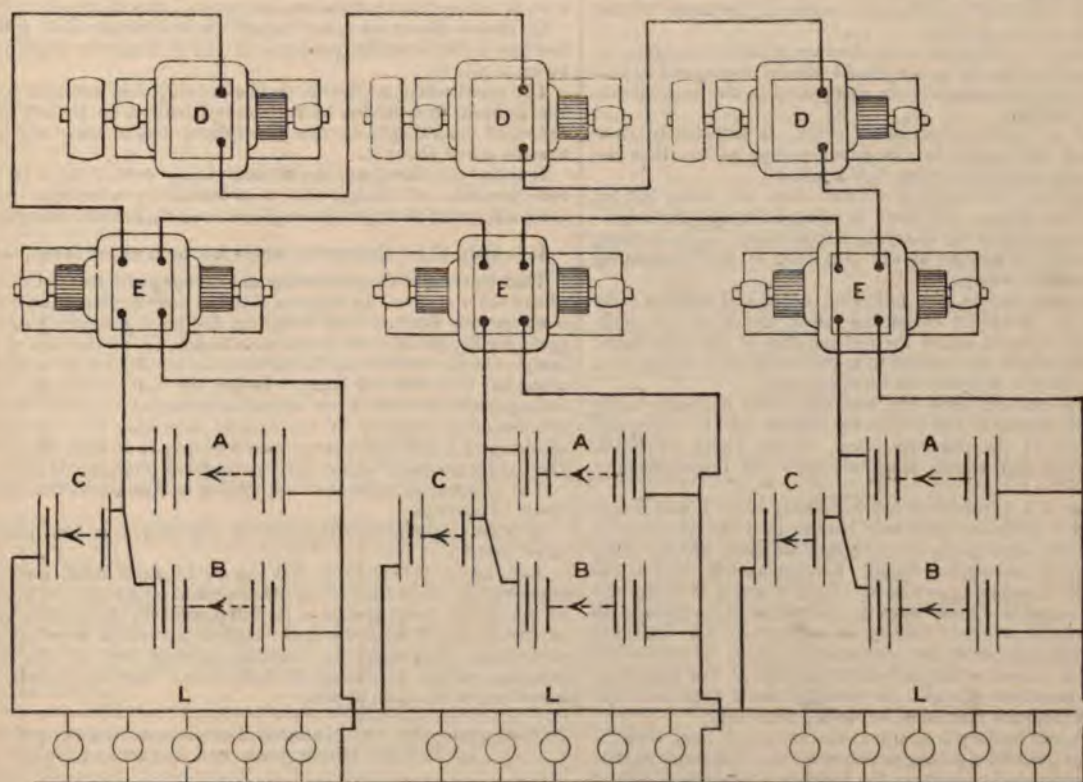
Arrangement 3.—The Two Batteries Discharging in Parallel.

In the second representation, the three plants are shown charging the second half batteries. Those which having been previously charging, are now discharging to the distribution system. Regulation is still maintained as in the first position.

In the third position, there is a cessation of charging, and the two

DESCRIPTION OF THE AUTOMATIC REGULATOR OF THE ELECTRIC POWER STORAGE COMPANY.

The charging mains arriving from the generating station are divided and connected to the groups of mercury cups of two "charging circuit relays."



Arrangement 4.—Continuous Current Transformers in Parallel with both halves of Battery.

half batteries are shown to be discharging together in parallel. Regulation is maintained as before.

In the fourth position, continuous-current transformers are supplying current to the system in parallel with both halves of the batteries. The apparatus for effecting the various transpositions of the secondary batteries in the storage stations, and for maintaining the pressure constant in the mains, is automatic.

These relays, C_1 C_2 , are identical in construction, and are really rocking switches, and come into action at the moment when the half batteries are just in or out of charge.

Their function is to introduce into the charging circuit a carbon resistance, O , between the time that one half battery goes out and the other enters, the position of being "under charge."

The groups of four cups on the outsides of these relays are half posi

tive and half negative, and the relative positions of the arms incline in the same direction.

To pull them into those positions and maintain them there, each arm is actuated from below by two electromagnets placed in a local circuit, to which I will refer further on.

When the right half battery, S_1 , is in charge, the right relay, C_1 , is in contact on its right (as it presents itself on the diagram). The positive and negative cups are respectively in connection with corresponding cups on the outside of the right-hand *transposing switch*, A_1 .

The intermediate terminals are severally connected with the poles of four sets, each of 54 cells, so that these 216 cells are in circuit in series.

On the way to the right-hand *charging circuit relay*, the positive conductor has formed the coils of a *charging solenoid*, marked E.

Its function is as follows: When the current is passing, the solenoid closes a valve in connection with a little gasholder, F, used to collect the hydrogen gas formed by one plate in one of the cells under charge. This cell is called a *master cell*. When no current traverses the coil of the solenoid, the valve is open, and no gas is retained in the holder.

At this point the duty of the holder, F, may be described. When the half battery is approaching full charge, gas is given off, and the valve alluded to being kept closed by the charging current, gas is retained by the holder, and commences to fill it.

The gas given off is collected first in an *ebonite gas chamber and acid trap*, marked H. The trap prevents any gas from this particular plate going anywhere else than into the gas chamber.

From the *chamber* the gas passes into a bubbling-bottle, G, with oil in it, which is intended to extract the moisture, and thence to the little holder.

The size of the holder is calculated so as to contain just sufficient gas as will be given off by one plate after the proper state of *milkeness* of the cells has been attained.

The moment it fills, a contact is made with the arm of a switch which is underneath it. This switch closes the *local circuit*, to which I have already alluded, as actuating the pulling-down magnets of the *charging circuits*, C_1 C_2 .

To return to A, the right-hand *transposing switch*. Let it be remembered that its right-hand contacts are dipped in their cups and the left-hand contacts are elevated out of them, and the charging current can go nowhere else but through the half battery.

Meantime, discharging into the lamp system is going on from the left-hand half battery, and while this is going on the right-hand contacts of the *rocking arm* of the left *transposing switch* are dipped.

These contacts are so arranged and connected with the poles of the four sets of cells that they are in position to discharge in parallel. It is evident that when the positions of the rocking arms of the two *transposing switches*, A_1 and A_2 , are reversed, the left half battery will be "in charge" and the right half battery discharging; and, again, that if the inner ends of the two rocking arms are dipped and they stand with opposing angles, then both half batteries are discharging, and charging has ceased.

Let us return to what takes place at the moment the arms of the switches rock into a fresh position.

Underneath each of these arms, as in the case of those belonging to the *charging circuit relays*, C_1 C_2 , are placed two electromagnets to pull them down. These electromagnets are also placed in the local circuit mentioned twice before.

This operation of rocking over, so to speak, is sufficiently slow between the break and make in the mercury-cups as to allow an interval of disconnection of less than half a minute.

During this interval the charging current does not cease, but for the time, as has been already described, is relayed through the resistance, O, by the operation of the *charging circuit relay*, C_1 , the rocking arm of which, instead of moving slowly like that of the *transposing switch*, moves instantaneously.

The operation is effected in the following order and manner: As has been stated, the gasholder closes the local circuit in the pull-magnets under the elevated end of the rocking arm of the right-hand *transposing switch*, which commences to move slowly over, aided by a balance weight rolling in a groove on its upper side.

As the charging contacts leave the mercury other contacts under the arm break the current in the pull-down magnet of the outer end of the *rocking arm* of the *charging relay*, which, being weighted, falls the other way, and effects simultaneously the introduction of resistance, O.

The rocking arm of A_1 continues moving slowly over. It first makes the contacts, which bring the right half battery into the position of discharge in parallel, and finally makes other contacts, which, acting on the local circuit through a small rocking switch, starts the rocking arm of the *transposing switch* A_2 . Its first action is to cut the left half battery out of the lamp system, and when it completes its journey to throw the left half battery in series into the charging circuit. At the same moment, by a separate contact, it closes the local circuit which actuates the pull-down magnet of the *charging-circuit relay*, C_2 , the effect of which is simultaneously to transfer the charging current from the resistance, O, to his next duty.

When the left half battery is charged, the next and final stage is carried out by the gasholder acting as before on the local circuit, the work of which is confined to inciting the rocking arm of the left-hand *transposing switch* to rock over, so that the second half battery goes to the assistance of its fellow.

A tell-tale wire back to the generating station from the *transposing switch* actuates a relay at the generating station the moment that the left-hand contacts lift out of the mercury. The current so transmitted actuates a relay which cuts off steam at the generating station.

On each side of the diagram are shown four resistance cells of the same type as those for accumulating, marked B, etc.

The duty required from them is as follows: 1. To supply counter E.M.F. with which to regulate the pressure in the lamp system,

2. To give the required energy to actuate what has several times been referred to as the local circuit, of which there are actually two—one for each side of the apparatus.

This brings us to the consideration of what occurs in discharging from the batteries.

In a system requiring a pressure of 100 volts, varying $1\frac{1}{2}$ per cent. above and below, that from 54 cells is excessive, even allowing for the fall between the station and the ends of the feelers. At the same time it is necessary to have ample reserve to meet occasions of heavy discharge.

To keep the pressure constant at the ends of the feeders, there must be tell-tale wires from those points to the E.M.F. governor, M, fixed on the governing board.

This apparatus is a fine wire coil in parallel with the feeders, and its function, when the E.M.F. is above or below the normal limit, to move a solenoid up and down. A lever bar connected with this completes a local circuit in a relay marked J, which in its turn actuates the two double-acting solenoids D_1 and D_2 , which operates simultaneously on sliding contacts in connection with *resistance switches* B_1 B_1 B_1 and B_2 B_2 B_2 .

These solenoids act as rheostats on the discharging circuit, by putting in or taking out the counter E.M.F. cells one at a time, and even two at a time.

The E.M.F. governor, M, is also in series, with a temperature compensator, marked L. This little apparatus keeps constant the resistance of the fine wire coil of M by altering the length of a carbon filament, which is in circuit with the coil of M.

This alteration of length, which minutely varies the resistance, is caused by the expansion and contraction of alcohol in a bent glass tube which presses on a column of mercury, into which one end of the filament is inserted.

As the bulk of the alcohol alters through temperature the mercury is pressed up or down, and less or more of the filament is short-circuited.

In order to maintain an equal discharge from each half battery, a *current balance*, marked K, is used.

This apparatus is made of two coils of large section copper, wound spirally apparently, but really cut out of a piece of copper tube.

The whole current from each half battery passes through one of these.

Should one half battery be giving current at such a rate as to run some 10 per cent. below the other, the coil acts solenoidically and completes the circuit in D_1 or D_2 , whichever may be affected, and thereby, through the intervention, as before, of one of the *resistance switches*, B, cuts out one of the counter E.M.F. cells.

The reduction of counter E.M.F. to the half battery which has been under discharging at once brings the two half batteries up to the same line.

The diagram shows at two places the connection to which the feeding mains of each kind are led.

At T is placed an ammeter to measure the total discharge into the feeding mains, which can be cut in or out. At the other pole is shown a set of safety fuses; these are also used on the other pole.

Of course there are many minor very important and interesting features of this beautiful invention of Mr. F. King's to which I have no space to allude.

The small relay, marked N on the drawing, has not been described, but I think it desirable to call your attention to it, not with the object of including it in the description, but in case any question may be asked about it.

It completes the local circuit and causes switch A_1 to be brought into position of charge. It is actuated by a current from the generating station when the engineer is ready to start charging.

It is claimed for the system which has been under description:

That the cost of the *generating and storage* plant does not exceed that of any other system. In support of this, I have a calculation before me, made by the Electric Power Storage Co. for a generating and storing plant for 30,000 30-watt lamps at £45,000, or at the rate of 30s. per lamp. On the same lines, the actual cost in Chelsea for a 9,000 lamp plant has been 40s. per lamp. Under the best conditions, the generating plant itself need not exceed in indicated capacity one-half of the maximum capacity of the system, assuming that the proportion of energy for which the consumers will pay is at least 70 per cent. of the energy produced at the terminals of the charging dynamos.

The economy in space thus acquired is equivalent to the demand for space for storage.

It is also claimed that the cost of the mains is less than in any other system.

And, again, it is claimed that the *working cost* must necessarily be considerably below that of any other system on account of the working of the motive plant always at its full power. To this particular feature of the system I wish to draw marked attention, together with the economical advantages in working, arising out of the complete stoppage of the machinery in motion each day for periods varying according to the time of year.

SPECIFICATION OF THE GENERAL CONDITIONS TO BE COMPLIED WITH IN WIRING HOUSES FOR THE ELECTRIC LIGHT.

Compiled for the use of the Customers of the Chelsea Electricity Supply Company, Limited.

The contract under this specification includes all conductors commencing at the point where the Supply Company's work ends, and all electrical fittings which do not actually form part of the lamp fittings. It includes no lamp fittings unless otherwise specified.

1. Except where otherwise specified, the whole of the work to be carried out in accordance with the rules of the Society of Telegraph-Engineers and Electricians, and the Company in whose office the building is insured,

2. In every room or closet throughout the house one light will be separately controlled by a switch at the door, placed so as to be of easy access to the hand immediately the door is opened. In dressing and bed rooms this light will be suspended over the dressing-table, the length of the lead to permit of the lamp fitting being about 7ft. above the door. In other rooms the light to be so controlled will be selected as being the one most likely to be in common use.

3. No lamp lead is to be less in cross-section than the equivalent to a No. 18 S.W.G., and in the case of floor connections less than No. 16 S.W.G.

4. All mains and sub-mains where not carried between floor and ceiling, will be placed in approved wood casing. Where carried between floor and ceiling, they will be laid between the joists or in notches cut in the same, not less than 6in. apart, and in no case will any pair of leads be carried between the same joists or through the same holes in partitions, etc. They will be painted throughout with asbestos paint: positive red, negative black.

5. Wherever between floor and ceiling branches leave the main, they will be laid with sufficient slack, so that the branches shall not approach nearer to the main of the opposite pole than 6in., the necessary cleats being attached to, and holes bored in the joists to secure that end.

6. When the lamp leads serve lamps in rooms with wainscoting or ornamental walls, where casing is not suitable, they will be led separately and by different routes to the point where the lamps are fixed, following the lines of the moulding or ornament; in such case they will be uncovered and fixed with saddles, and in no case, except where casing is used, may lamp leads approach nearer than 2in. of each other.

7. Where there are wall hangings or tapestry the lamp leads will be carried behind the same, if not in casing, as prescribed for, between floor and ceiling.

8. In the case of plain walls lamp leads will be laid in casing from the floor upwards, or the ceiling downwards, which will be let into channels cut in the walls. Should it be desirable not to disturb the decoration or paper, they will be laid on the face of the wall, and secured by saddles. In such case the colour of the covering of the conductor should harmonise as much as possible with the colour of the walls.

9. A wooden wall block will be fixed at every point where a lamp, wall plug, switch, or cut-out, are specified to be fixed under the contract; except where panelling or stone ornament already exists, when special means of attachment must be arranged for.

10. Distribution-boards will be supplied and fixed if required, and will carry the following fittings besides the necessary terminals. To each circuit and sub-circuit will be furnished a switch and double-pole cut-out.

11. When a distribution-board is not required, a cut-out will be fixed at, or as near as possible to, the junction with each principal branch with the main.

12. Cut-outs will not be fixed at any other point in the system than those referred to in 10 and 11 except at each lamp.

13. Wall plugs, unless otherwise specified, will be fixed 2ft. 6in. from the floor, and where there is a dado they will be fixed above the top rail.

14. Floor plugs will make connection through a plate of insulating material laid flush with the floor, and the sockets will not be less than 3in. apart, and must be open at the base, so that dust may fall through into a cavity beneath.

15. Unless otherwise specified, the ends of the leads to serve lamps, of which the fittings are destined to be attached to the walls, will be left, so that the future fittings can be fixed anywhere between 4ft. 6in. and 7ft. above the floor.

16. Samples of all electrical fittings of every kind, and a drawing of the distributing boards will be submitted, and be subject to approval before being fixed.

17. Any deductions from, and additions to, the contract will be made only under instructions in writing from the superintending engineer, and no day work will be undertaken without his instructions; and no claim for such day work will be admitted unless a daily time-sheet for the same is handed to, or sent to, him on the following day.

To this follow pages on which to draw up the number, nature, and position of the lamps, the descriptions of the route of each circuit, and a form of agreement to be entered into by the contractor.

SPECIFICATION FOR THE SUPPLY AND LAYING DOWN UNDERGROUND OF ELECTRICAL MAINS FOR THE CHELSEA ELECTRICITY SUPPLY COMPANY, LIMITED.

The contracting company is the Callender's Bitumen Telegraph and Waterproof Company, Limited.

(1) *Route.*—The routes to be followed to be as nearly as possible those shown in the plans attached, but where necessary by reason of unforeseen obstructions they may be changed subject to the approval of the Chelsea Company.

(2) *Excavation.*—The trenches to be made in the foot or roadways as the case may be to be on the routes described. The depth under the footpaths shall be as little as is consistent with safety. When under the roadways the depth of the trench shall be two feet under, or such other depth below the surface level of the roadway as the nature of the paving or macadam may require. When necessary, to avoid existing obstacles, pipes, etc., this depth may be increased or diminished, subject to the conditions of safety.

(3) The existing paving of all kinds to be removed, and on completion of work replaced. The execution of the whole of this portion of the contract to be subject to the satisfaction of the surveyor of Chelsea parish, and to be carried out in terms of any orders or rules he may lawfully make, and to conform to conditions laid down in clauses 13 to 19 inclusive and in clause 76 of the Chelsea Electric Lighting Order Confirmation Act of 1886, 50 Vic., cap. xviii.

(4) *Open Trenches.*—The work to be so carried out that no one section of greater length than 100ft. shall remain open for 48 hours.

(5) *Notices.*—All the notices which are laid down in the above-named Act as obligatory in connection with the works shall be given by the Chelsea Company, who shall relieve the contracting company of any responsibility in consequence of any neglect on the part of the Chelsea Company to comply with the requirement, but at the same time the contractors shall be required to give the Chelsea Company ample notice over and above the time of notices prescribed by the said Act to enable the Chelsea Company to fulfil its conditions; and, in case of the contracting company's defaulting to do so, the said company shall not be relieved from loss or responsibility arising out of any such failure on their part.

(6) *Plans.*—The plans and drawings made in duplicate, as prescribed by the said Act, shall be prepared by the contracting company and delivered to the Chelsea Company.

(7) *Deposit.*—Any deposit which the Vestry may require as a guarantee for the proper reinstating of the footpaths and roadways shall be made by the contracting company, and all arrangements connected with the same shall be made directly between the Vestry and the said company.

(8) *Negotiations with Vestry.*—Although the Chelsea Company shall give all the legal notices required by the Act, or otherwise, the negotiations with the Vestry, their surveyor, or contractors, as to the actual mode and time of doing the work shall be carried on by the contracting company, advice of same being given to the Chelsea Company.

(9) *Cable Cases.*—In the trenches as described, cable cases shall be placed and jointed together into continuous lengths. The cases shall be of the Callender-Webber type, of the sizes and with the number of ways as specified in the schedule.

(10) *Cable Cases.*—The cases shall be made of the best bitumen concrete, of the same quality as those laid in 1887 at the Borough-road works of the Anglo-American Brush Electric Light Corporation Limited. The thickness of material between the individual ways and between the ways and the outside of the case shall be at least half an inch. The inside of the ways shall be made truly circular in section and equal in area throughout, smooth and free from projections or roughness of any kind.

(11) The cases shall be made in lengths of 6ft. each, the ends trued to fit each other, and they shall be jointed together by means of saddle-pieces and bitumen cement, and with the assistance of suitable mandrills for each separate "way," so that the ways shall be equal throughout and watertight, and the inside of the ways at the joints in every respect of the same section, within at least $\frac{1}{16}$ th of an inch, as smooth and free from roughness as elsewhere. Tight joints shall also be made between the E.M.F. draw, and service, boxes, and the lengths of casing which join them.

(12) No bends shall be allowed of a shorter radius than —; they shall all be such as will allow the cables to be drawn in or out with ease, and the line of casing shall be laid out to avoid all unnecessary divergences from the straight or level. No curved length of casing will be used in which the circular section of the ways has been altered in form by the process of bending.

(13) Drawing-in cords to be provided by the contracting company, and left in the ways as and when the cases are laid. When cables are drawn in, these cords to be used for drawing in the necessary drawing wires, which will be recoverable by or be returned to the contracting company, retaining their property in the interim.

(14) *Drawboxes.*—Drawboxes to be provided at all points as follows:

- (a) All changes in direction of line of 90deg. or thereabouts, or where changes of direction prevent the use of curves.
- (b) At all points of junction between one main and another.
- (c) Sudden alterations in level.
- (d) All straight lengths, in which boxes do not occur for the above reasons once in every 100 yards.

(15) The drawboxes must be securely joined to the main casing. The covers of the boxes to be of cast iron, resembling the Post Office specification of weight and thickness, and to be of the designs, dimensions, and patterns agreed on between the managements of the two companies.

(16) If during the progress of the work it is found expedient to place additional boxes, this shall be done by the contracting company on orders being given by the Chelsea Company.

(17) *E.M.F. Boxes.*—The distributing or E.M.F. boxes to be placed at the points shown on the attached drawing and marked —, or elsewhere, if required. They will be constructed of brickwork in cement, or laid in bitumen, and with floors and covers of best York landing. They will be constructed on the general design shown on the attached drawing, modified to suit the particular conditions of each case. The copper junction pieces to which the mains are jointed will be of special design, suitable to each position, and the joints with the same, and their insulation shall be made in all respects as mechanically and electrically secure as the joints in the rest of the system, described elsewhere.

(18) *Service-Boxes.*—Service-boxes to be of cast iron, and to be provided and fixed in number at least one for every two houses as shown in the schedule No. These to be of the design, dimensions, and pattern, agreed on between the two companies. Wherever possible only one line of distributing cables to be interrupted and pass through these service-boxes. Service-boxes and house connections to be fixed either at the same time as the casing is laid or subsequently, as found most convenient.

(19) The cables used to be made as follows:

Conductor.—The strand to be of copper wire of high conductivity guaranteed not less than 98 per cent. that of pure copper. Each wire to be tinned separately and to be of the size shown in schedule.

(20) *Dielectric.*—To consist of a solid sheath of bitite (vulcanised

bitumen) put on under pressure to a diameter of not less than the dimensions named in the schedule.

(21) *Tapes.*—The cable to be taped over the dielectric three times with prepared tape and compounded between each. Braid to be of hemp yarn closely plaited and served with liquid bitumen compound, then with an asphalt compound, and finally passed through black-lead to facilitate drawing into the way. The cables to be coiled on large drums, having a boss of not less than 3ft. in diameter, and not to be subjected during manufacture or afterwards to any undue strain by bending or otherwise.

Joints in Cables.—(22) The joints between the sections of the cables, each to each, to be made by a long soldered joint in the conductor. The seven central wires to be run together solid, and each of the outer wires to be individually jointed to the corresponding wire in the other cable. The wires to be short and long alternately on each cable to form a strong marriage joint. The whole to be then bound with fine copper wire, and soldered over all.

(23) This conductor to be lapped with tape, and then covered in not less than three thicknesses with sheet bitite, made specially for this purpose. The whole to be well welded together, and to be finally protected by strong prepared tape and compound.

(24) Each joint when finished to be tested for insulation and conductivity. In each draw and distribution box a maximum of 3ft. and a minimum of 1ft. slack to be left on each cable for the purpose of allowing the sections of cable to be drawn backwards or forwards a few inches from time to time to prevent adhesion to the insides of the cases, and to secure their freedom, and the possibility of at any time withdrawing the cables for the purpose of maintenance.

(25) *Service Joints.*—The joints of service leads to the mains for house supplies to be T joints, and made as described above, except that the service wire will be jointed on the main by passing through the centre of the main, and lapping three times round the strand, the whole to be then firmly soldered and insulated as before described.

(26) In the service-boxes care to be taken that the joint is as near as possible in the middle of the space, so as to allow the cable being safely moved when drawn periodically backwards and forwards to prevent adhesion. The service-leads to have sufficient slack in the box to allow of this being moved without strain to the mains.

(27) *House Connections.*—House connections to be provided from each service-box to within the boundary-wall of the premises, and such connections to consist either of a two-way Callender-Webber case, or of a cast-iron pipe carrying two cables, each of the size required to supply the current to be agreed on with the customers. A price to be paid for all such connections as shown in the schedule. This to include breaking through and making good the house or area walls.

(28) During the execution of the work the Chelsea Company to have free access for purpose of supervision to all parts of the work, and their representative to have the right to reject any labour and material which he considers in the interest of the work should not be employed, and upon receiving written notice to that effect from him the representatives of the contracting company will cease to use the same.

(29) Every separate length of cable shall be tested for its insulation resistance after having been drawn in to the casing and placed *in situ* before being jointed to the next length. The result of each such test must give infinity with a Wheatstone bridge, Post Office pattern, both between the conductors and between each conductor and earth; the current used to have an E.M.F. not exceeding 100 volts.

(30) The next test will be of the same lengths when jointed together from end to end from a station to a feeding-box. From this test the same result will be required.

(31) Similar resistance results will be required from the distributing mains before the house service branches are joined in as from the charging and feeding mains. C. E. WEBBER.

NEW COMPANIES REGISTERED.

John Wild and Company, Limited.—Registered by Hooper and Son, 69, Ludgate-hill, E.C., with a capital of £10,000 in £5 shares. Object: to carry on the business of mechanical and electrical engineers, steam, gas, and air engine makers, iron and brass founders, etc. Registered without articles of association, and consequently the regulations of table A in the first schedule of the Companies Act, 1882, apply.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts of this Company for the week ended September 27 amounted to £2,867.

West India and Panama Telegraph Company.—The receipts of this Company for the half-month ending September 30 were £2,206, against £2,050.

Submarine Cables Trust.—The coupon, due in April last, of the Submarine Cables Trust, will be paid in full by Messrs. Glyn, Mills, and Co. on the 15th inst.

Telephone Company of Austria, Limited.—This Company has declared the usual half-yearly dividend to the 30th inst. on the preference shares at the rate of 6 per cent. per annum, payable, less income-tax, early in October.

Western and Brazilian Telegraph Company, Limited.—The receipts for the week ended September 27, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £1,623.

PROVISIONAL PATENTS, 1889.

SEPTEMBER 23.

14953. **The application of the electric bell to the "knockers" of hall doors of hotels, hospitals, public institutions and those of medical and clerical gentlemen by a special process.** M. J. Kenny and George Barry, Bridge House, West-street, Tallow, Co. Waterford.

14971. **Improvements in secondary batteries.** Paul Joseph Rodolphe Dujardin, 323, High Holborn, London.

14991. **An electricity meter for alternating currents.** Otter Titus Bláthy, 28, Southampton-buildings, London.

SEPTEMBER 24.

15028. **Regulating mechanism for arc lamps.** William Brooks Sayers, 24, Glycena-road, Lavender-hill, London.

15044. **The automatic ringing of a bell or gong at any single needle telegraph station, when that particular station's code is given.** John Henry Smith, Woodland Station, Broughton-in-Furness.

15045. **Improvements in electric switches and safety fuses for supply station distributing boards.** Charles Mark Dorman and Reginald Arthur Smith, 24, Brasenose-street, Manchester. (Complete specification.)

SEPTEMBER 25.

15138. **An improved grapnel for submarine cables.** William George Stafford, 53, Chancery-lane, London.

SEPTEMBER 26.

15155. **Improvements in the mode of storing and renewing the secondary batteries of electric tram cars.** Alfred Dickinson, 77, Colmore-row, Birmingham.

SEPTEMBER 27.

15230. **Improvements in electric batteries.** Sir William Vavasour, 33, Chancery-lane, London.

15235. **Improvements in dynamo-electric machinery.** Frederik Vilhelm Andersen, 14, Westdown-road, Catford, London.

15246. **Method or means of regulating motor-dynamos or continuous current transformers.** Wilhelm Lahmeyer, 433, Strand, London.

15248. **Improvements in electrical switches.** Charles Henry Cathcart, 8, Quality-court, London.

SEPTEMBER 28.

15272. **Improved apparatus for adapting telephone line wires for use in synchronizing clocks.** Alfred George Burrell, 62 St. Vincent-street, Glasgow.

15293. **Viewing distant objects by means of electrical apparatus and conducting wires.** Arthur French St. George and Agnes St. George, Cotswold House, Earlswood, Redhill, Surrey.

15303. **Improvements in electric bells.** Walker Moseley, 37, New Oxford-street, London.

15308. **Improvements in driving dynamo-electric machines.** John Alexander McMullen, 24, Southampton-buildings, London.

15311. **Improvements relating to telephonic apparatus.** Edgard Jette, 45, Southampton buildings, London.

SPECIFICATIONS PUBLISHED

1888.

12609. **Electrical locks.** Thompson (Lémonon). 8d.

15206. **Transmitting telegraph, &c., signals.** Brown. 8d.

15433. **Secondary batteries.** Handford (Duncan). 8d.

15877. **Secondary batteries.** Rousseau. 8d.

15921. **Electric railway signals.** Siemens. 8d.

18718. **Telegraph, &c., posts.** May. 6d.

1889.

11927. **Covering electrical conductors.** Pitt (Atherton). 8d.

12402. **Galvanic battery solution.** Kookogey. 4d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name	Paid.	Price Wednes-day
12 Feb.	1/2	Anglo-American Brush E.L.	—	4½
12 Feb.	2/0	— fully paid ..	—	5½
14 Nov.	0/4½	Con Telephone & Main ...	1	4½
27 July	10/0	India Rubber, G. P. & Tel.	10	19½
.....	...	House-to-House	4½	5
.....	...	Metroptn Electric Supply	—	3½
.....	...	London Electric Supply ...	5	4½
.....	...	Swan United	3½	5½
12 July	12/0	Telegraph Construction ...	12	43½
2 July	6/0	— 6%, 1889	100	105
... ..	...	National Telephone	5	6½

NOTES.

Nottingham.—The Town Council of Nottingham have decided to apply for a provisional order.

Fareham.—A company has been formed, with a capital of £5,000 in £1 shares, to supply electric light in the district of Fareham, Hants.

Bradford.—The committee of the Bradford station are in communication with the makers of accumulators, and possibly these will be available by Christmas.

Electric Apparatus.—The stock-in-trade, fixtures, and goodwill of the Electrical Apparatus Company now in liquidation is offered for tender by the liquidator, at 4, Charing-cross.

Art Fittings.—The Globe Electrical and Engineering Company having taken up the sale of artistic electrical fittings, the name will be changed to the Globe Electrical and Art Fittings Company.

Junior Engineers.—Prof. Perry, F.R.S., will be president of the Junior Engineering Society for the ensuing year. His inaugural address will be on "Mechanical Engineering in Electrical Industries."

O.S.A. Dinner.—The Old Students' dinner at the Manchester Hotel (near Aldersgate-street Station) is fixed for 7 p.m. on Saturday. Members and their friends are invited. A few tickets (4s.) can be had at this office.

Book Received.—We have received a copy of "The Law Relating to Electric Lighting," by G. Spencer Bower, B.A. (of the Inner Temple), and Walter Webb (solicitor of the Supreme Court), published by Messrs. Sampson Low and Co.

Barnsley.—At the meeting of the Barnsley Town Council the recent public meeting was referred to, and it was moved and carried that the Council receive the resolution of the public meeting and give its earliest consideration to the question of electric light.

Electric Light Strike.—A Central News telegram dated New York, Oct. 8th, says that 200 employes in the Edison Electric Light Factory, at Harrison, New Jersey, have struck work in consequence of their wages having been reduced by 20 per cent.

Miners at Birmingham.—An excursion of the North Staffordshire Institute of Mining and Mechanical Engineers was undertaken last week to the Electrical Exhibition at Birmingham. The artificial coal mine and the telfer line received a good deal of attention.

Electrical Patents.—A Belgian syndicate, represented by M. Leon Somzee, of Brussels, has bought of Messrs. Lee, Ross and Co., of London and Paris, for the sum of 3,000,000f. the patents of a new electrical apparatus, said to be of great importance to the commercial public.

Technics.—The fact that there are now thirteen British students at the Berlin Technical High School in training as engineers and chemists, ought to stir our technical advisers both to greater exertions and to a more extended publication of their claims and possibilities.

The Weems System.—At the 1892 exhibition, Mr. D. G. Weems has applied for the exclusive right of building an electric road all round the New York World's Fair in 1892. He promises a speed of five miles a minute, and says that the passengers will travel "safely and in great luxury."

Bakery Lighting.—A fine example of electric light installation in a bakery is that of Messrs. J. B. Stevenson and Co., whose well-known works at Battersea have 200 incandescent lamps. A Phoenix dynamo is used, the whole of the work being carried out by Messrs. Paterson and Cooper.

Paris Awards.—The announcement must be added to the list of awards at the Paris Exhibition given last week, that a gold medal has been awarded to the Compagnie Générale des Lampes Incandescentes of Paris for their exhibit of "Edison-Swan" lamps. The Thomson-Houston Company have received the Grand Prix.

German Electric Tramways.—A suggestive note comes from Berlin. The Grand Tramway Company, of Berlin, has commissioned two of its chief engineers to go to New York and study the electric street railways of the States, making a full report upon the application of electric traction with a view of its speedy introduction into the German capital.

Electric Shares.—The electric shares we noted last week as having risen very rapidly are, it must be noted, the original "Swan" shares, and not Edison-Swan. The latter shares are only £3 paid and are not quoted on the Stock Exchange. It is necessary to be clear about this, as even shareholders themselves sometimes do not seem to be quite sure which shares are alluded to.

Comparative Estimates for Tramways.—The Julien Electric Traction Company have issued a neat little pamphlet giving a number of detailed estimates as to the cost of running street railways by horse, cable, conduit system, or storage battery. The figures in the last case are based on the work done on the Madison-avenue road by the Julien cars now running there.

Wire Wove Roofing.—In case of new buildings for electrical undertakings it might be well to take notice of the new unbreakable substitute for glass, wire wove roofing. It consists of a web of fine iron wire covered on both sides with a thick translucent varnish made from linseed oil. It is waterproof, unaffected by steam, heat, or cold, and is capable of being bent to any angle.

Sale of Plant.—It will be seen by the advertisement that a sale by auction will be held by Messrs. Wheatley Kirk, Price, and Goulty of the works and effects of the firm of Appleby Bros. The sale will last three days, and will include a large quantity of engineering tools and appliances, and especially a number of various types of steam-cranes, of which the firm were manufacturers.

Portsmouth.—The town of Portsmouth is to have the electric light. An electricity supply company has already applied for powers, and the contract for the erection of a central station has been given to the House-to-House Company, and will be similar to that at West Brompton. A large number of hotel keepers and tradespeople in Portsmouth are giving the scheme their support.

Electric Sewing Machines.—The Electric Light Company of Berlin are introducing sewing machines driven by small electric motors supplied from their central station. The price for a strong tailoring machine is not over 3d. per hour, and quite a number are being employed. Meanwhile, we know of no single case of this kind in England driven from the current from a central station.

Electric Workmen's Trade Union.—What may be an important matter to the electrical profession, was decided

on Saturday last, at The Paul's Head, Paul-street, Finsbury, where a meeting of electric engineers and linesmen, of whom it is estimated there are about 3,000 in London, met to inaugurate a trade union in London. A letter advocating that course was read from the Manchester Union.

Devonshire Club.—We understand that an entirely new departure in lighting is being made at this club, the object being to obtain the effect due to light in shade now too often overlooked. The contract for the work has been given to Messrs. Drake and Gorham, who are acting under the superintendence of Mr. Faulkner Armitage, of Altrincham, whose artistic wrought-iron fittings are becoming well known.

The "Daily News" Articles.—In Article No. V. (Oct. 7) of the series on electric lighting of London appearing in the *Daily News*, Mr. Crompton's work at Kensington and Knightsbridge comes in for its share of notice. The beauties of always having a storage of electric energy to draw upon are alluded to, and the amalgamation of all the West-end low-tension systems in one company is hinted at as not unlikely.

Show Your Motors.—In reference to our recent note upon exhibiting motors in shop windows, we learn that Messrs. Rashley, Phipps, and Dawson, in their new premises in Berners-street, W., are adopting a plan of this kind. They have arranged the Immisch motor which drives their machinery in a prominent position, so that the work it is doing, the ease of fixing, and its compactness can be recognised by all passers or callers.

"Electric Light."—We begin to see about the larger streets of London those neat little plates let into the pavement at intervals, labelled in letters of iron with the magic words "Electric Light." When people passing continually see these evidences of distribution day after day under their very noses, it will not take them long to recognise the fact that the electric light is now very close to their houses, and we welcome these standing advertisements with satisfaction.

Westinghouse.—The Westinghouse Company have removed from their offices in Gresham-buildings, and have taken unto themselves offices at 4, Victoria-mansions, Victoria-street. English engineers are interested to see what will be the outcome of the invasion, as the field is a good deal altered since the first American machinery came to England, when English machines and systems were not so complete, nor the field so well gone over. Now, however, we shall see what they can do.

New York Tramcars.—If events may be relied upon, the most noted street in America—Broadway, New York—will soon have its complement of electric cars. Overhead wires will be out of the field here, and experiments are now going on with an accumulator car of the Electric Car Company of America. This is running among the horse cars. The line is a very difficult one to work well, owing not only to the crowd of passengers, but to the immense amount of carting of goods that goes on continually in this great thoroughfare.

Anglo-American Brush.—The obsequies of the valiant old Father Brush were carried out yesterday afternoon, when the list of shareholders who become contributors to the new Brush Electrical Engineering Company was settled. The chairman, Mr. E. Gareke, reported business exceedingly busy, both for orders and on account of the extension of the Falcon

Works at Loughborough. Each £5 shareholder would receive one preference share of £2 and one ordinary share of £3 in the new company. No objections being raised the meeting dissolved, no resolution being submitted.

City Lighting.—The question of considering the tenders for electric lighting in the City again came before the fortnightly meeting of the Commissioners of Sewers on Tuesday, when it was again pointed out by Mr. Sly and Mr. J. C. Bell that members were still without a copy of the committee's report, and therefore were asked to deal with a most important matter while they were entirely in the dark. The chairman said the report was now in course of being printed, and would be in the hands of members in a day or two. Under these circumstances it was agreed that a special meeting of the court be called for next Tuesday to finally deal with the question.

Electrical Accessories.—A company under the name of the Electrical Accessories Company has been formed to take over, as a going concern, the manufacturing business of Messrs. S. Atkins, Hockley, Birmingham. Mr. Atkins is the inventor of a number of ingenious novelties, which he has been manufacturing by the hundred gross, at prices which when compared with the present cost of electrical apparatus appear extraordinary. It is with a view to utilising the talent and experience of Mr. Atkins in developing the details of electric lighting such as switches and fuses, that this business has been acquired. The offices of the company are situated at 66, Victoria-street, which is becoming quite a nest of electrical engineers.

Electric Supplies.—What a centre of electrical activity the Mansion House Station corner is becoming. Not only is a new store of new and secondhand electrical plant getting ready just near, as alluded to elsewhere, but Messrs. Woodhouse and Rawson have taken large premises in the same central position, right opposite those of the General Electric Company, who have long been removed to this position and have a fine show. Messrs. Buller, Jobson, and Co. are just round the corner also, and the Telegraph Construction Company, of Helsby, have been in the same neighbourhood. Curiously enough, it seems that the latter firm are going to 11, Queen Victoria-street, as Woodhouse and Rawson came away from this address.

Electric Measurement of Heat.—The admirable Cantor lectures by Mr. C. Vernon Boys, F.R.S., upon his electric micro-radiometer are appearing in the current numbers of the *Journal of the Society of Arts*. It will be remembered that this instrument is based upon the variation in a small thermopile couple carrying a reflecting mirror, and hung on a delicate and practically invisible spun quartz thread, in an intense magnetic field, the sensitiveness of the instrument being such that it is equal to clearly indicating the heat from a single candle at the distance of one mile. Mr. Boys gives an account of previous instruments for the measurement of radiant heat, a subject which he treats exhaustively in these lectures, and also gives directions for mounting the quartz threads.

A New Fume Arrester.—Messrs. Drake and Gorham have recently patented a new method of preventing the fumes from batteries which are at times found to be troublesome. The most usually adopted method is to place glass slabs over the top of the cells. This, however, only partially stops the smell, and the glass requires constant cleaning. The use of a solid sheet of paraffin poured on the liquid renders it impossible to get at the plates, in case a particle of oxide requires to be removed. This difficulty

is overcome by the new arrangement, which consists of a specially prepared light substance, floating on the top of the acid to the depth of about $\frac{1}{4}$ in. It is absolutely innocuous to the plates, and can be pushed on one side without trouble.

Italian Business.—A correspondent of the *Financial News* sends an extract from an Italian financial newspaper, the *Sole*, which tells of a piece of what they term fatuous imbecility on the part of a London firm of electrical engineers. This firm wrote to its Italian customers announcing that, in consequence of the banking crisis, they would not execute any Italian orders save for prompt cash. Substantial Italian houses naturally resented this, and several of them at once remitted the balances due by them, and announced that in future they would have no dealings with the said London firm. The Italian paper adds that the productions of that English firm are not indispensable, and hints that business will in future be done with people who can trust Italian merchants to meet their obligations in spite of a financial crisis.

Worcester Applies for an Order.—At the meeting of the Worcester City Council held last week, the Mayor pointed out that the Watch Committee at its last meeting considered the question of recommending the Council to apply to the Board of Trade for a provisional order authorising the supply of electricity in Worcester, but passed no resolution on the subject. He now moved that the Council apply for a provisional order. If they obtained the order they were not themselves bound to use the powers it conferred, but could make terms with one of the numerous companies which existed, whereas if they allowed some other body to obtain those powers over their head they might find themselves in an awkward position. Alderman Willis seconded, and after some conversation the motion was carried.

City and Guilds of London Central Institution. At the termination of last session, the John Samuel Scholarship was gained by A. E. Young, and the Siemens medal for the student of greatest merit in the department of electrical engineering by C. G. Lamb. At the entrance examination for the new session, held this month, the Clothworkers' Scholarship of £60 a year, tenable for two years and renewable for a third year, entitling the successful candidate, in addition, to free education, was gained by H. C. Haycraft; the Mitchell Scholarship of £30 a year for two years, with free education, by F. H. Hummell; the three Institute's Scholarships, of sufficient value to cover the student's fees, each tenable for three years, by R. W. Weekes, H. E. J. Taylor, and E. G. Ingold; and the Public School Scholarships, entitling the successful candidates to free education, by R. L. Jenks and C. Mills.

Flour Mill Lighting.—The large flour mills of Messrs. Ridley and Sons at Chelmsford have been lighted by Messrs. Christy and Norris, Chelmsford. A 90-light Crompton dynamo is used with a 8 h.p. engine, but arrangements are made so that the dynamo can either be run from the special engine or the mill engine. The lamps are fitted in Messrs. Christy and Norris's special hand lanterns, attached to a pliable cord some five or six yards long. The lamps are fitted with handles, and reflectors which serve the double purpose of keeping the light from the manipulator and concentrating it upon the desired object. A strong wire guard protects the glass, so that they cannot well be broken. If they are by any means, the air at once extinguishes the light. The use of such portable lights, without heat or dropping fire,

in a flour mill must be apparent. They have also proved very useful instead of the smoky oil lamps in cleaning out the boiler.

Column Printing Telegraph.—Some little trouble is likely to arise over Messrs. Moore and Wright's column printing telegraph, which, it will be remembered, prints news in any quantity, at any number of offices, in sheet form like a typewriter. Sir William Thomson, a few weeks ago, went to inspect these instruments, and took some trouble in taking to pieces the mechanism, and paid the inventors a very high compliment upon its action. Mr. Fletcher Moulton, Q.C., we have heard, has given it as his opinion that the patents are unassailable, but notwithstanding this, the Exchange Telegraph Company, whose domains will be greatly infringed on its practical introduction, are going to challenge the rights. Mr. Moore will fight it out in the courts before exploiting the invention practically, and thinks they will undoubtedly win. The result, if this is the case, upon the Exchange Company cannot but be disastrous, as they will have a most serious competitor if the new printing telegraph carries the day.

"Electrical Plant."—Our monthly contemporary, *Electrical Plant*, devoted to the sale and exchange of electrical machinery, has entered into a new sphere of activity. The proprietors, Messrs. Wheatley Kirk, Price, and Goulty, the well-known auctioneers, have taken a large warehouse at 39, Queen-street, near the Mansion House Station, approaching Southwark Bridge, which will henceforth be the head offices of the paper. It will also be a storehouse of both new and secondhand electrical goods of all kinds, where purchasers may inspect, hire, or purchase what they require. It is a large five-storey building, and each floor will be devoted to specialities. The basement will contain engines and accumulators, and also their own gas-engine for supplying light to the place; the ground floor, dynamos, motors, pulleys, and other machinery; the first floor, glass and arc lamps; the second floor, fittings, switches, holders, instruments, and other apparatus; and the third floor will be packing-room, and also contain stores of wire cable, belting, etc. Being right in the centre of London activity, the enterprise ought to prove very successful.

Edinburgh Exhibition.—A committee has been formed for the purpose of interesting the citizens of London in the Edinburgh Electrical Exhibition, and the Lord Mayor-elect, Sir Henry Isaacs, has consented to act as president of the London committee, and as one of the vice-presidents of the exhibition. The co-operation of the Mayor and the Corporation of Glasgow is also being sought. The Electrical Committee, under whose management the electrical branch of the exhibition will come, has now been constituted. It consists of the following gentlemen: A. R. Bennett, general manager, National Telephone Company; Principal Grant Ogilvie, Heriot-Watt College; Prof. G. F. Armstrong, Edinburgh University; J. Gibson, superintending engineer, postal telegraphs; A. F. Clement, telegraph superintendent, North British Railway; Dr. A. C. Elliott, Edinburgh University; D. A. Stevenson, engineer to Commissioners of Northern Lights; Colonel Malcolm, Royal Engineers; J. Monteith, Carstairs House; G. Auldjo Jamieson; and Hugh Auld; the three last being gentlemen locally identified with the progress of electrical science.

Spanish Lighting.—The Electricity Supply Company for Spain has been formed with a capital of £100,000 in

19,900 ordinary shares of £5 and 100 founders' shares. It has been formed primarily for erecting a central station in Madrid under a concession recently obtained by Senor Don Pedro y Landero, of Madrid. The contract has been given to Messrs. Hammond and Co. for a plant similar to that at West Brompton, for 25,000 8 c.p. lamps (about 1,500 h.p.), purchase of the site and "remuneration for obtaining the concession" for £80,000. The remaining £19,500 will be in hand for mains and for maintenance. The founders' shares are to be allotted to Mr. Hammond as fully paid up in consideration of his defraying the preliminary expenses and registration. Half the profits, after 7 per cent., goes to the holder of the founders' shares—on the whole a highly satisfactory arrangement for Mr. Hammond. We do not find any estimate of the cost of laying mains in Madrid, and as the company do not intend to confine their attention to Madrid, "but, as favourable opportunities occur, contemplates extending its operations to other important towns in Spain"—it does not exactly appear that £19,500 is a just proportion for this large amount of proposed work.

Phoenix Works.—On a visit to Messrs. Paterson and Cooper, Phoenix Works, Dalston, we found them, as, indeed, we are now pleased to find all electrical engineers, very busy with work of all kinds. A new 250-light compound dynamo was just going off to Peter Robinson's, who is constantly extending his installation. This is for incandescent and arc lighting in parallel, a feature which Messrs. Paterson and Cooper have made a special one with their dynamos and lamps, and one which, in such cases as shop lighting, seems to be greatly appreciated by business managers. A complete plant in a very compact form destined for special train lighting of some magnate in the Far East has just been finished. This comprises an engine, boiler, dynamo, and all fittings, and is intended to go into one special van for lighting the train. A special dynamo for ship lighting looked also a very compact and serviceable plant, with a small vertical engine and a 200-light dynamo, running at 300 revolutions. Besides this, they have a set of three Phoenix dynamos in hand for the Penarth Docks, where arc and incandescent lamps are both to be used. The order for this has been placed in the hands of Messrs. Paterson and Cooper by Messrs. J. B. Saunders and Co., of Cardiff, who are the contractors for the dock lighting. The Phoenix arc lamps are also to be employed here.

Gas or Electric Light.—The half-yearly meeting of the Commercial Gas Company was held last Friday, in which the growing interests of electric light had to be touched upon. The extension of gas for cooking purposes, now looked forward to as the ultimate use of gas, was, of course, insisted upon, but Mr. Geo. Livesey, chairman of the South Metropolitan Gas Company, said, probably very truly, that if gas should ever be superseded for lighting purposes, and be relegated to cooking purposes, the companies might as well "shut up shop," for they were not at all likely to live by supplying gas for cooking purposes alone. He comforted himself with the beauty of the lighting by gas of the sea-front at Brighton, and maintained that the price at which the company were selling gas was quite sufficient to ensure their continued prosperity. Sir Robert Rawlinson endorsed the remarks, and observed that, although an enormous amount of capital was now embarked in trying the electric light on a grand scale, gas proprietors need not despair. He hoped that the electric light scare would not alarm any holder of gas stock in

the London companies. In this, however, he cannot control the holders of gas stock, and whatever may have been the case at the first announcement of Edison's discovery, the position is now, with scores of central stations springing up all round, very different indeed, and we should think that if Mr. Livesey's saying is true, that the gas companies are in reality to look to lighting for their continued prosperity, that the alarm of the holder of gas stock is likely to be very genuine.

Paddington.—At the adjourned meeting of the Paddington Vestry, held on Thursday last week, after some continued discussion upon the advisability of undertaking the work by the Vestry, it was eventually resolved that steps should be taken to secure its being done by private enterprise under an approved provisional order. It was also resolved to refer the matter to an electric lighting committee of 11 members to prepare a draft provisional order by making such modifications in and additions to the latest model order issued by the Board of Trade as to provide for two complete systems of public lighting extending throughout the borough, so that the two systems may be used concurrently or separately from time to time; that all stations for the production and supply of electricity should be within the borough of Paddington, and the systems, both for public and private lighting, to be confined to the borough, with the exception that, subject to the approval of the Vestry, they may be extended to any part of Chelsea detached, and to such parts of other adjoining parishes as are within 100 yards of the boundary of Paddington; that the local authority shall, if it so desires, be entitled to purchase the undertaking at the expiration of 21 and 31 years respectively; that the committee be authorised to consult the Vestry solicitor in the preparation of the draft provisional order, and to advertise for proposals from companies and others for undertaking the supply of electricity under the conditions of the draft provisional order; all proposals to be sent in, under seal, addressed to the Vestry, to be opened in the vestry in the manner provided for the opening of tenders, and then to stand referred to the Electric Lighting Committee for consideration and report.

Mining Motors.—It is gratifying to find that the electric motor for mining purposes is beginning to "bite," and repeat orders for plants which have been ordered experimentally are coming in, showing that those who have the control of the mining machinery are beginning seriously to appreciate the manifold advantages of electric power. Messrs. Locke and Co., of St. John's Colliery, Normanton, have recently added a hauling and pumping plant for working their mines, supplied by Messrs. Immisch and Co., in addition to the original motor plant, which was for pumping. Recent tests of the later plant have shown that the motor is capable of giving 50 h.p. continually, with only a stoppage of half an hour per day for cleaning. In actual work it is often run 22½ hours out of the 24. The first plant was fixed for pumping only, but the second plant has been so arranged that by means of gearing it can be employed either for pumping or hauling, which adds greatly to its utility. At present the motor is running at 380 revolutions only—half its full speed—so that in case of need the work of the motor can be doubled. From Messrs. Bowes and Partners, Durham, a repetition order has also been received. The first plant has been running some four or five months, and the second order has just

been completed. This is for about a 3 h.p. motor, pumping for about 3,000 yards. A motor has also been working successfully for some time at Lintithgow, in Scotland, at an oil works and quarry. Messrs. Partridge, Jones, and Co. have a 20 h.p. motor running. This was originally ordered for pumping purposes, but a fall occurring in their mines this was abandoned, and the motor was arranged for hauling, at which work it is now successfully and constantly employed. It is interesting also to hear that orders for mining motors are arriving from the Continent. Messrs. Immisch are supplying a complete outfit for a 20 h.p. motor for pumping, to be used in a tin mine in Bohemia.

House, Works, and Church Lighting at Pontardawe.—Mr. Arthur Gilbertson, of Pontardawe, has just had an electric light installation fitted up for the lighting of his tinplate works, his residence, All Saints' Church, and the reading room for his employes, and hopes to save £150 a year by the substitution of electric lighting for gas, which he has obtained hitherto from his own gas works. The installation at Pontardawe has been carried out by Messrs. Paterson and Cooper, through their local agent, Mr. John Legg, of Nelson-street, Swansea; the installation being designed and carried out by their engineer, Mr. G. H. Nisbett. The generating plant has been placed in a substantial stone engine-house, specially erected for the purpose. The plant consists of a 16 h.p. nominal high-pressure engine, working at 90lb. pressure. The engine and boiler, when worked to their full power, are capable of giving 50 i.h.p. Two dynamos of Messrs. Paterson and Cooper's well-known Phoenix type are used, driven by belting direct from the engine flywheel. One dynamo, capable of running 120 lamps of 16 c.p. each, is in use for the lighting of the church and residence, and the other machine, which is capable of running 300 16-c.p. lamps, drives the light in the works. Slate switchboards, with measuring instruments, are fixed near each dynamo. To meet the variation in resistance, the pressure for the house, which is nearly a mile distant, is 125 volts, while for the works the pressure is only 60 volts. There are 116 incandescent lamps and 14 arc lamps in the works, with the result that there is now an excellent light in every corner of the building. The mills are lit by 1,000-c.p. arc lamps, one lamp between each two mills. Each mill has, in addition, two incandescent lamps for the shears at the back of the rolls. The cold rolls are lit by incandescent lamps, one to each pair of rolls. The tin-house is remarkably well lit by two 1,000-c.p. arc lamps, and, in addition to these, each stack has two 16-c.p. incandescents. The sorting-houses generally are lit by arc lamps and incandescent lamps over the benches. The annealing and pickling houses are lit by 600-c.p. arc lamps. The stores, offices, smithy, and fitting shops are all lit by incandescent lights, and the sidings at night are illuminated by 1,000 candle arc lamps. The workmen speak of the new light in terms of the highest praise, and describe it as being in every way better, and much more convenient to work by. The reading-room connected with the works has also been lit with several incandescent lights. The road between the works and the church is lighted at intervals by electric lamps. All Saints, Pontardawe, is the first church in Wales lit by electricity. The present mode of lighting inaugurates a very great improvement, and the effect is admirable. The arrangements here, like those at the works, are complete. Thirty 32-c.p. lamps and 11 16-c.p. lamps have been fixed to the

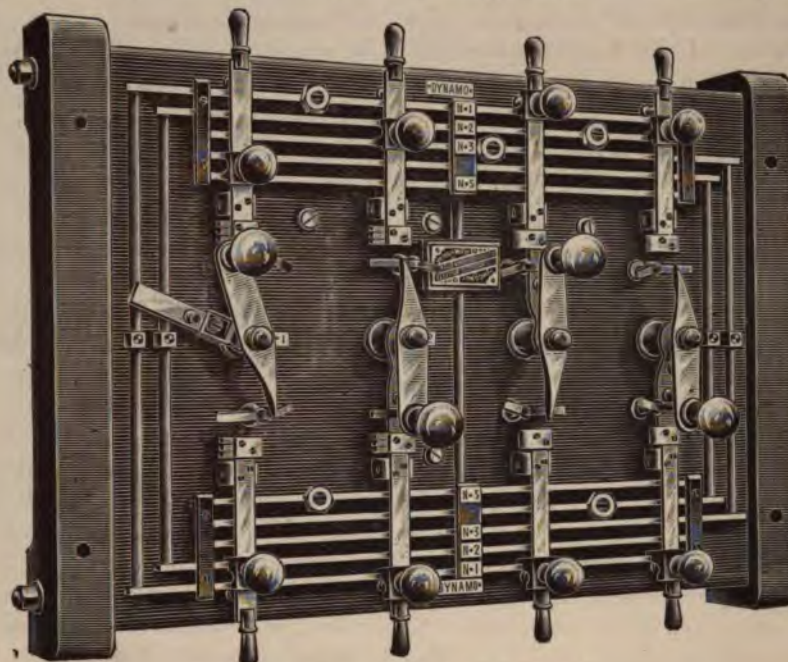
old gasfittings, but the wires are throughout carefully concealed. In Mr. Gilbertson's residence there are about 90 lamps in the house, stables, and laundry. The fittings in the drawing, dining, and music rooms are most elaborate and artistic, and harmonise extremely well with the general decoration of the rooms. Exquisite taste has been shown throughout. The light is brilliant and satisfactory in every particular, and the fittings and shades are beautiful and effective. The electric light has done away with the noxious fumes of the gas, the improvement in the atmosphere is very marked, and Mr. Gilbertson expresses himself well pleased with his installation.

Exeter Theatre.—The new Exeter theatre was opened on Monday evening with a performance of "The Yeoman of the Guard." The house is lighted by electricity in a most effective manner, all the latest improvements having been provided. The current, which is supplied from the Exeter Electric Light Works, is under complete control from the prompt side of the stage. This is effected by a group of switches mounted on a handsome slab of polished slate. From these switches, 30 in number, separate circuits run, so that by this means any part of the house can be lighted or not at will, and the lights raised or lowered in a rapid and certain manner. The lighting of the stage is carried out by means of the usual float, proscenium, batten, and side lights, the total number of the lights being 357 of 16 c.p. each. The auditorium is to be lighted from a powerful 50-light electrolier, suspended from the centre of the dome, and a number of prettily-designed two-light copper and brass brackets round the walls of the dress circle. The saloons are lighted by three and five-light pendants, which are in some cases brass and in other cases iron. This brings the total number of lamps to 510. The fittings in the theatre have been supplied and fitted by Messrs. B. Verity and Sons, King-street, Covent Garden. The directors of the theatre are fortunate in being able to obtain their current from a central station, as it relieves them from the trouble of generating it themselves, which would entail a much greater annual expenditure. The arrangements at the Exeter Electric Light Company's station are such as should assure the customers of that company of a highly efficient supply of current. The plant now being placed consists of two horizontal non-condensing compound engines, by the firm of J. Fowler and Co., of Leeds. Each of these is capable of delivering 150 h.p. These drive two of the Brush Company's Mordey alternators for the supply of the incandescent lamps, each dynamo being capable of supplying a current for 4,000 lamps. For the current to supply the arc lamps, the Electric Light Company use Thomson-Houston dynamos. There are two dynamos of this type, each capable of supplying 35 arc lamps of 1,200 c.p. each, which give here, as elsewhere, a most steady and brilliant light. These are driven by two non-condensing triple expansion high-speed Westinghouse engines, of 30 h.p. each. The steam is supplied to the engines from two Babcock and Wilcox water tube boilers, working at a pressure of 150lb. per square inch. At the station the current is under complete control from the station switchboard, from which any supply circuit can be started at will, the pressure regulated, and a complete record of the current leaving the machines be taken. At present there is plenty of spare power and plant to completely duplicate the whole of the lighting arrangements, and as this power is used fresh plant will be added to ensure a continuous supply. The Exeter station is designed for a total capacity of 20,000 lamps.

THE BRUSH COMPANY'S CENTRAL STATION SWITCHES.

The great extension in central lighting has induced the Brush Electrical Engineering Company to give great attention to the various parts of apparatus or fittings that should pertain to a connected system, and they have just completed some designs of high and low tension switches for

nected to its own dynamo. At the top and at the bottom are corresponding receiving jaws, to either of which they can connect. Each of these jaws has a handle, to which a movable contact is fitted; these contacts can be lifted and fitted down over either of the transverse bars. The transverse bars are joined in couples, top and bottom, each couple connected to a separate circuit. To throw over a dynamo to another circuit, therefore, the jaw not in use corresponding to that dynamo is lifted and pressed down to the required circuit bar. The switch-handle is then



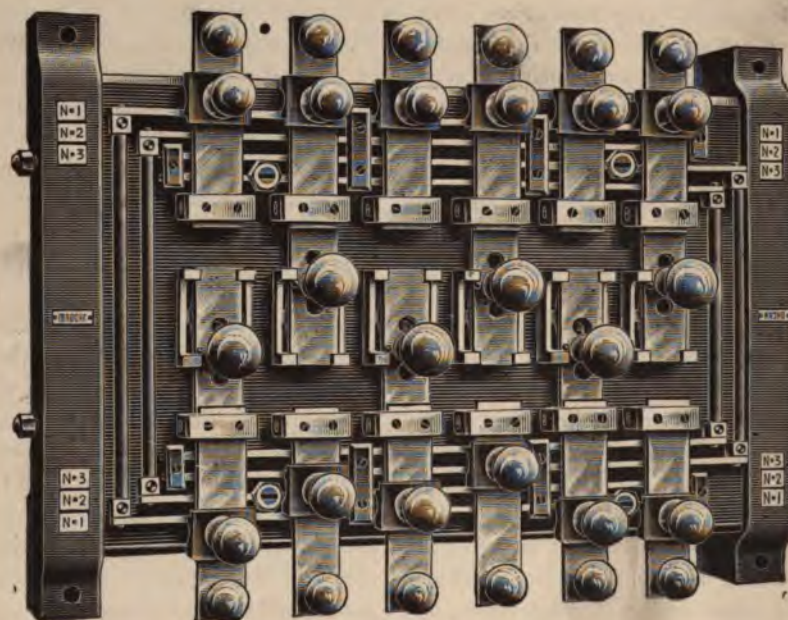
Brush High Tension Central Station Switch.

use in central station work which embody some evident advantages.

The idea, in both types of switches, is that of mechanical arrangement to allow of a certain number of dynamos to be connected with all or any of a

pushed hard across, and the current is, of course, shunted to the new circuit.

In the high-tension switchboard the same arrangement of dynamos and circuits is made, but the switch is of a different pattern, giving a long break to obviate the spark.



Brush Low Tension Central Station Switch.

given number of circuits, in such a manner that these can be changed over with ease and certainty. In the low-tension switch, a solid and heavy bar slides along by means of an ebony handle into jaws consisting of split pieces of stout copper. To these are connected one end of the cable, and the other end is connected to stout springs, which press up underneath the sliding piece, thus making good contact.

In the switchboard a series of these sliding bars are arranged, as shown, in the centre of the board, each con-

In this a handle on a loose pivot catches against a small trigger and releases an arm carrying a contact piece. This arm is actuated by a powerful spring, and the act of moving the handle causes it to fly round instantaneously, the break being of course twice the radius of the arm. The connection of dynamos to the various circuits is made in the same manner as the former to the transverse bar connection. A locking arrangement prevents the arm flying back accidentally, and is only unlocked by again altering the circuit contact.

ALTERNATING CURRENT MOTORS: THE EVOLUTION OF A NEW TYPE.*

BY LIEUT. F. JARVIS PATTEN.

On giving our secretary the title of this paper it was my purpose to treat the subject in a broader light, and to show the progressive steps in a series of experiments which led eventually to the type of machine that I shall bring to your notice this evening. The recent and urgent claims of other work have rendered such a treatment impossible at the present, and I shall limit the paper to a description of a new alternating-current motor, one form of which is shown in the accompanying drawings.

The place that the alternating-current electric motor is destined to fill in the industrial arts is familiar to you all, and the various ways known to the scientific world by which such machines may be rendered operative have been ably considered and elaborately discussed in the institute papers of the past two years by Prof. Thomson, Dr. Duncan, and Mr. Tesla. We are thus all more or less acquainted with the prominent difficulties of the problem.

My experience in common with that of my predecessors teaches that the alternating-current motor has a strong and persistent disposition to stand still, and when persuaded to motion it is apt to be a sort of "go as you please" machine and asserts its inherent right to turn in either direction indifferently, direction of rotation in some cases being purely a matter of chance. I shall not have much to say about efficiency, as my experiments with large machines are not sufficiently advanced to furnish any reliable data, but I will endeavour to give a general solution of the problem designed to meet the following conditions of practice:

1. A machine that will start itself independently of the speed of the generator or number of alternations of current per unit of time.
2. A machine that has but one direction of rotation and cannot reverse under any conditions of current alternation.
3. A machine that is not necessarily synchronous with the generator, revolution for revolution.
4. A machine in which reversals of current direction do not produce corresponding reversals of magnetism in any iron part when the machine is in motion at its normal speed and maximum efficiency.
5. A machine of simple form, having an ordinary continuous wound armature revolving in a single or two-pole field.

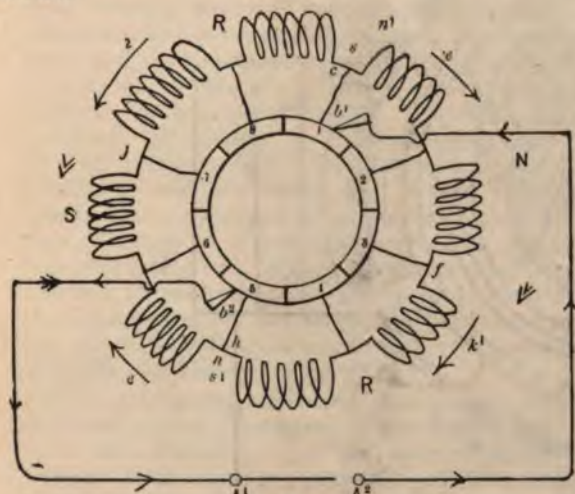


FIG. 1.

Referring, now, to the figures which are simply diagrams of the circuits and operative parts, we have in Fig. 1 an ordinary closed circuit armature shown as a Gramme ring merely for convenience of illustration, the points of the winding intermediate between the eight coils being connected in the usual way to the eight segments or bars of an ordinary Gramme collector, and it may be well in passing to note here the functions of this collector. It is not a commutator in the strict sense of that term, as it does not rectify or redirect reverse or opposed currents. If the brushes, b^1 and b^2 , were held upon the outside wire of the

ring, the same results would follow, and the Gramme collector, properly so called, singly transfers the brush contact from point to point of the continuous ring winding. If a source of direct current be interposed between the terminals, A^1 and A^2 , current will flow continuously from brush b^1 to b^2 downward through the right and left-hand halves of the ring in the direction of the arrows k^1 and k^2 , making, say, a south pole in the ring at the upper point, S , and a north pole at the lower point, n . With a continuous current these poles would be continuously maintained and placed in the magnetic field indicated by N and S the armature would continuously revolve in the direction indicated by

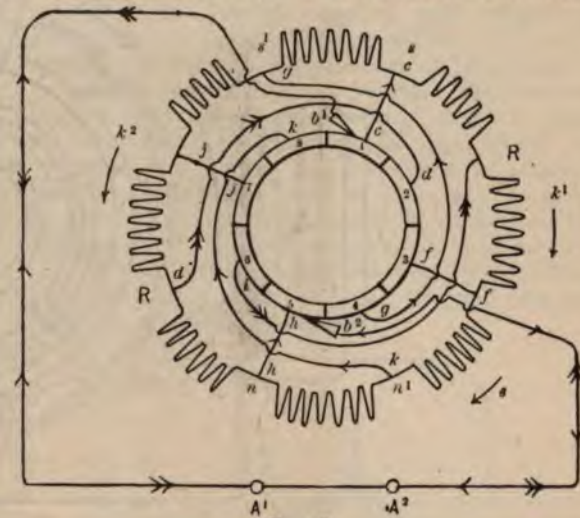


FIG. 2.

the arrows $E E$. If now a source of alternating current be inserted between the terminals, A^1 and A^2 , the polarities of the ring would be reversed at each successive alternation of current, and if a direct impulse indicated by the single arrows in the external circuit produced the poles n and s in the ring, the reverse impulse indicated by the double arrows would produce the opposite polarities, n^1 and s^1 , at the same points, and the tendency to motion would be reversed if the fields remained the same, but it will be noted the motion would be in the same direction still if the fields were also reversed by the same reversal of current. If, however, the fields were maintained constant as



FIG. 3.

indicated by the large letters N and S , and some device could be contrived by which at each reversal of the alternating current, the brushes b^1 and b^2 could be made to change position, either mechanically or otherwise, then with an alternating current a constant polarity, s and n , would be maintained at the upper and lower points of the ring—for then a direct impulse, starting from A^1 to the right, would enter the ring through the brush b^1 , flowing down both sides in the direction of the arrows k^1 and k^2 , out through brush b^2 , and back to the source at A^1 . The reverse impulse indicated by the double arrows would start from A^1 to the left, going to brush b^2 ; and if we now

* Paper read before the American Institute of Electrical Engineers.

suppose this to have changed places with the brush b^1 , the reverse current would then enter the ring at s , and flowing down both sides in the direction of the arrows k^1 and k^2 , would leave through n and the brush b^1 , and so back to the source a^2 , maintaining the polarity of the ring the same as before. If the brushes could be thus changed at each alternation, the polarity of the ring would be maintained constant with an alternating current. While, however, it is quite impracticable to thus cause the brushes to change position mechanically at each reversal of current, it is perfectly feasible to produce the same effect without the

right, go to brush b^2 , which we will now suppose bearing on segment 4 of the collector, whence it will go by the inverse connection to the opposite point, B^1 , of the ring, then down both sides in the same direction as before to the point n^1 , thence back to the opposite segment 8, out brush b^1 , now bearing on this segment, and back to source at A^1 .

The reverse currents, therefore, under the assumed conditions are caused to maintain a constant polarity in the ring, so that in a constant field its tendency to motion would always be in the same direction with an alternating current in the armature. It will be further noted that the

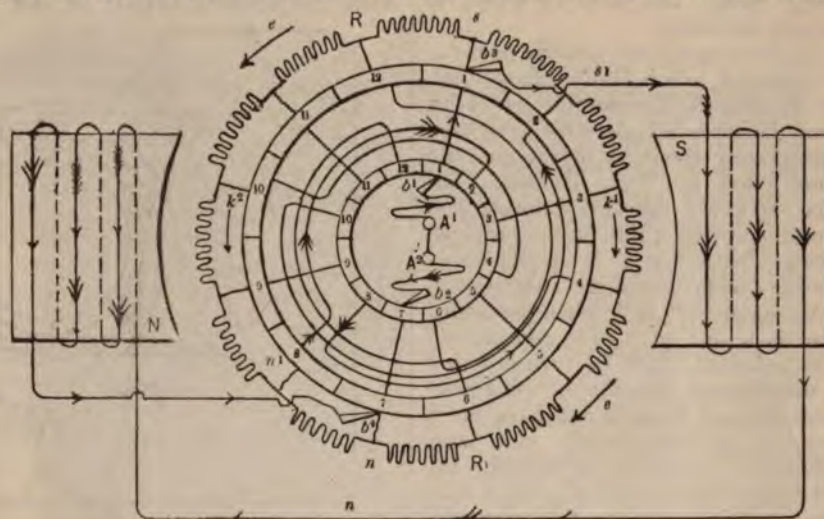


FIG. 4.

mechanical change. The means of accomplishing this result are indicated in Fig. 2, which is identical with Fig. 1, with a single exception. There are eight coils, as before, and eight bars in the collector; the odd numbered bars, 1, 3, 5, and 7, are connected to the same points of the ring as before c , f , h , and j , but the even numbered bars, 2, 4, 6, 8, are connected respectively to points of the ring diametrically opposite them, bar 2 to the point d , bar 4 to the point g , and so on, each even numbered bar to a correspondingly opposite point of the winding. If now a source of alter-

alternating current is not redirected or commuted in the strict sense of the word, and we may enunciate the fundamental principle which underlies the construction of this type of machine as follows:

The poles of any closed circuit may be maintained constant with an alternating current by causing opposite impulses to traverse the circuit in opposite directions. The direct and inverse connections, shown in Fig. 2, have precisely this effect, when, as supposed, a single bar of the collector passes under the brushes at each reversal of cur-



FIG. 5.

nating current be interposed between the terminals, A^1 and A^2 , and we make the single supposition that the ring shall turn through an arc of the circumference equal to that covered by one bar of the collector during each alternation of current, we shall still maintain a constant polarity at the upper and lower points of the ring without causing the brushes to change position mechanically.

Thus a positive impulse starting from A^1 to the left and indicated by single arrows enters the ring at b^1 , flows down both sides to n , producing the ring polarities s and n , out brush b^2 and back to source at A^2 . The reverse impulse being in the opposite direction will start from A^2 to the

rent. The connections $c c$, $d d$, $f f$, etc. in Fig. 2 may have any form, and other bars may be interposed between their extremities without affecting in any way their functions as connectors. This step is shown, in Fig. 3, where another collector bar, $1 c$ $2 d$, $3 f$, etc., is inserted in each of the connections $c c$, $d d$, etc., of Fig. 3, thus making another collector shown outside the first to avoid confusion of the drawing, while, for the same reason, the source of alternating current, $A^1 A^2$, is placed inside the inner ring. As the polarities, s and n , of the ring are maintained constant, as previously described, with an alternating current, and current is constant in direction from s downward

through the right and left halves of the rings to n , so must necessarily any current be constant in direction which is led from brushes through any shunt circuit connected to the segments, $1c$ and $5h$, of the outer collector; a field circuit of constant direction may therefore be shunted from this outside collector. This is shown in Fig. 4, in which 12 coils are shown in the ring, and 12 bars in each collector connected alternately direct and inverse, as before. Tracing now two opposite impulses of current, we have the first indicated by the single arrows from source A^1 to segment 1 of the inner collector, thence to segment 1 of outer collector, where the current divides, part going down the right and left-hand halves of the ring to n , and part out brush b^2 through the field circuit, making the poles N and S back to brush b^1 , segment 7, of outer, and segment 7 of inner collector to the terminal A^2 of source. If the armature be supposed now to turn through the space covered by one collector bar, the reverse impulse can be traced as follows: Starting at A^2 in the opposite direction to brush b^2 , now bearing on segment 8 of the inner collector, thence through the reverse connection to segment 2 of the outer collector, now under brush b^2 , where the current divides, going part as before down the right and left halves of the ring, making a south pole at s^1 and a north pole at n^1 as before, and the other part out of brush b^2 , through the field circuit in the same direction as before, back to brush b^1 , now on segment 8 of the outer ring, thence through the reverse connection back to segment 2 of the inner ring, now in bearing with brush b^1 , and so returning to the source at A^1 . Thus the two impulses of opposite direction have been made to traverse both armature and field circuits in the same direction. We have, therefore, with an alternating current constant armature polarity and constant field polarity, and therefore a constant tendency to motion in the same direction. Not only this, but the further condition is fulfilled that there are no reversals of magnetism in any iron part so long as one bar in the machine, as shown in Fig. 4, passes under the brushes at each alternation of current. It remains to show how this is brought about. Referring again to Fig. 4, let it be supposed that the first impulse of current did not cause the armature to turn through the arc of the circumference subtended by one segment, but all the branches still bore on the same segments as shown in the figure and the reversals of current continued. By tracing the circuits it will be seen that each reversal of current reverses the polarity of both field and armature, and with either direction of current or rapid reversals there will be a constant tendency to motion always exerted in the same direction. The machine under these conditions becomes therefore simply a direct-current machine on an alternating-current circuit, with a constant tendency to start in one direction. Assuming the machine therefore self-starting, it will continually gain in speed until the condition is fulfilled of one segment passing the brushes at each alternation, for it then becomes in the broad sense a synchronous alternating motor, the current then produces no reversals of magnetism, and there is a true alternating current in the armature circuit, producing, however, no reversal of armature polarity; and a current of constant direction in the field. Under these conditions the motor is self-regulating, moving at a constant speed and with a maximum rotary effort.

It is not, however, essential that one bar should pass the brush at each alternation, as any number may be caused to do this depending upon the speed required and the number of coils upon the armature. This is illustrated in Fig. 5, where the complete machine is shown. There are 24 coils in the armature, 24 bars in the outside collector, and 32 bars in the inside one, this latter being composed of 24 connecting and eight insulating bars. The connecting bars of the inner ring are numbered to correspond with those of the outer ring around to the right from one to 24—the insulating bars, drawn shaded, separate the others into groups of three. In this machine three segments 1, 2, 3, in the outer ring are connected direct to the corresponding segments 1, 2, 3 of the inner ring, likewise the opposite three, 13, 14, 15, of one ring are connected direct to 13, 14, 15 of the other. The next group of three is connected inversely, 4, 5, 6 of the outer ring to the diametrically opposite bars 16, 17 and 18 of the inner ring, and the cor-

responding opposite group, 16, 17, 18, of the outer ring is likewise connected inversely to the diametrically opposite group 4, 5 and 6, of the inner ring. The remaining segments are connected in the same manner, but the connections are omitted to avoid confusion in the drawing. The operation of the machine is evidently the same as that shown in Fig. 4, except that the required conditions are fulfilled in this instance when three bars of the collector pass under the ring at each alternation of current, and as there are 24 segments, arranged in groups of three, the machine at its normal speed would make one revolution for every eight alternations of current, and connected in a circuit supplied with 16,000 reversals per minute its normal speed would be $\frac{16000}{8} = 2,000$ per minute, and with 48 segments arranged in groups of three, its speed would be 1,000 per minute. The blank segments insulating the groups of the inner ring are connected to the extremities of a rheostat, $Rh. Rh.$, which is enclosed inside the commutator, and is designed to offer a path for the alternating current such as there may be, and prevent its absolute rupture at the period of change from one group of segments to the next; they also serve an important purpose in preventing a dangerous short circuit, which would be occasioned by the inner brush bridging two groups of segments oppositely connected.

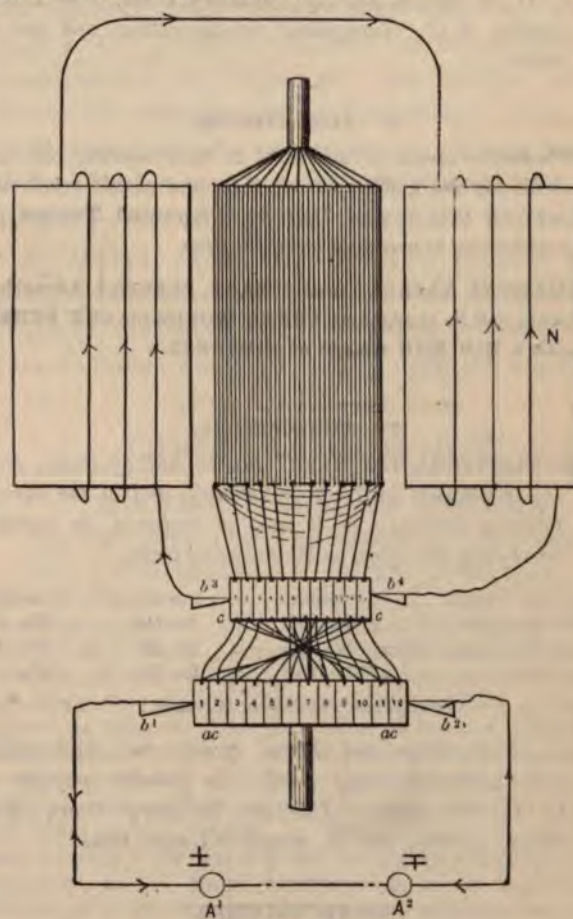


FIG. 6.

It follows, as a matter of course, that as the machine starts as a direct-current motor connected in an alternating circuit, rapid reversals of magnetism will at first be produced in all the iron cores, and these should be made of laminated iron to prevent undue loss by heating at the period of starting. The machine, in fact, starts as a direct-current motor, and automatically changes to a sort of synchronously alternating motor. When it gains its normal speed at this point it is self-regulating, and its capacity of doing work is a maximum.

Fig. 6 shows a plan of the machine as constructed; it consists simply of an ordinary closed circuit armature in a single field; c, c is the ordinary collector, really a part of the armature circuit, from which the brushes, b^3, b^4 , take a current of constant direction to the field-shunt; $a c, a c$ is the reversely connected commutator and the brushes, b^1, b^2 , bearing upon this commutator are connected to the terminals of the alternating-current circuit.

THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence ; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices :

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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IMPORTANT NOTICE.

We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No paper that we know ever refuses Subscribers or Advertisers. Nor do we; in fact, we invite them, believing that they will get full value for their money.

Specimen copies of the paper will be sent on request.

THE STRIKE WAVE.

Just as in natural physical phenomena, a series of earthquake shocks visit certain regions of this terrestrial globe, so civilised humanity is from time to time troubled with a series of social cataclysms, which upset peaceful life in all directions. London has in this year of grace, 1889, experienced a series of strikes, the effects of which cannot be traced until many of those who have taken part in them have crossed the boundary of that "bourn from whence no traveller returns." We are told that the devil, in the guise of a serpent, tempted our maternal ancestor. At the present time he tempts the British workman in the guise of the political intriguer. The modern tempter is as wise as the ancient one, in that he appeals to the credulity of his listener. The text of the strike master seems to be that wages can be raised, hours of work reduced, all existing labour utilised, and the bulk of business remain constant or rather proportionally progressive to the natural labour increase, and this text is dinned into the working man, as Butler says, "with fist instead of a stick." In fact, Butler might have had this time of social strife in mind, instead of the religious strife about which he declaims so vigorously in *Hudibras*—

When civil dudgeon first grew high
And men fell out they knew not why;
When hard words, jealousies, and fears
Set folks together by the ears—etc.

The great strikes of to-day are but the preliminary battles of a sustained attempt, first, to raise wages all round; secondly, to reduce the hours of labour; so that in the end the workman realises as much for the fewer hours' work as he has heretofore realised for the longer, and this result, the workman is told, is certain without endangering any loss of work. Well, conclusions differ when arrived at by different people, and our view is that of Carlyle, the world is made up of wise men and fools, mostly fools, and in our view the class mostly fools includes both those who preach and those who believe the doctrines above mentioned. At any rate nothing is more certain than while there is a superabundance of labour no strike can interfere with wages except temporarily. A strike may dislocate business, it may and indeed often does ruin a particular industry in a particular locality throughout all time. An evening contemporary is great upon the statement that this company or that company makes so many thousands profit during the year, and therefore should pay its workmen more money. This is an argument equivalent to saying the advertisement columns of the *Star* bring in double this year to what they did last, so the proprietors ought to pay the compositors and contributors double wages. With placards all over the place telling us of the "astounding," the "extraordinary" success of this petulant but able daily, we have never heard

that this gigantic success led to any other than ordinary business arrangements between employer and employed. Yet its cry is like that of the parson, "Don't do as I do, but do as I tell you." In all the controversy about possibilities of higher wages, grand profits, and responsibilities, has any single one of the sapient writers and spouters who hound on men to strike ever enquired into one particular case and investigated the true facts. We shall discuss the general and not the particular question, and we defy any of these men to prove our contention incorrect. Our text shall be a successful company, preferably one quoted on the Stock Exchange. Now, are there or are there not constant dealings with the shares? Our experience is that most of the dealings are regulated upon a five or six per cent. basis—that is, the investor purchases at a price that he expects will give him a five or six per cent. return for his investment. We are not taking things as they ought to be, we must take them as they are. If a five pound share is bought for fifteen pounds because a fifteen per cent. dividend is paid, the investor does not get fifteen per cent. for his money. Nor does the nominal capital of the company really represent the capital at stake. Calculated upon the original prospectus and in the case of original shareholders fifteen per cent. is good, but how many original shareholders exist in any company after a period of twenty years' working? The question to be asked is, what consideration have these political and social agitators towards the actual owners of the shares? They receive a modest five per cent. for their investment, and nothing more. They invested upon the natural conclusion that the wage would be regulated somewhat in the natural way—by freedom of contract, and supply and demand. They cannot afford to decrease the net profits, nor can the management afford to increase wages or decrease prices, because the management is bound to more or less consider things as they are and not as they might be. We are taunted with "huge profits obtained, at the price of the labourers' blood," by members of Parliament, parsons, and others, but is that so? How many of these men are getting more than a five or six per cent. on their investment? Is this method of fighting a fair method? Is this system of continued mis-statement one that is calculated in the long run to command or deserve success? Take the case we have imagined, what results from a rise in wages or a decrease in prices but an immediate drop in dividends? This results in the sale of shares at lower prices, and a consequent loss to the investors, and so the matter will go on till the concern is ruined beyond hope of recovery, or common-sense comes into play to stop irretrievable disaster. Suppose the works driven out of the market, where is the benefit to the labourer then? Do we mean to say that the position of master and man is perfect? Most emphatically, No. But this

we do say, the position never was and never can be made better by means of indiscriminate strikes. If one works stops, the workmen can go elsewhere, say the advisers of the men. Why then, in the name of all that is good, don't they go elsewhere in the first place if they are not satisfied with their condition? They have a perfect right to refuse to work at any price, but they have no right individually or collectively to intimidate others who are known to be willing to work. Unfortunately, nothing we can say or do can counteract the evil counsels of the writers and speakers who have deliberately taken up the path of misleading those who cannot know the true facts of the case. We intended in the first instance to have discussed more particularly the state of affairs at Silvertown, but have diverged into a wider field. Mr. Tyler's letter in another column, which was received too late for insertion last week, will show that there are two sides to this question, and from our knowledge of the management at Silvertown we accept without demur his statement giving the version of the case as it appears to the management. We are heartily desirous of seeing men really living instead of lingering, but cannot say one word in favour of these strikes. The real problem for solution is the proper distribution of labour. Put it where it is required, not endeavour to create an artificial condition of things when it is a drug upon the market.

CORRESPONDENCE.

THE PURIFICATION OF SEWAGE.

TO THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—I shall be obliged if you will permit me to make some comment in your columns with regard to certain opinions expressed by Mr. Webster in his paper on "Purification of Sewage." On page 247 in your issue of the 27th ult., Mr. Webster makes an attack upon the use in sewage treatment of precipitants containing sulphate of iron. I quote as follows: "Sulphate of iron has one great drawback, the production of sulphide of iron due to the organic matter combining with the oxygen of the salt." In my opinion, and in accordance with my experience, sulphide of iron is not formed in the majority of instances, and when it is formed it is not due to the reduction of the sulphate, and I would further state as an argument in favour of precipitants containing iron sulphate that if the production of the black sulphide is due to the deoxidation of this sulphate, then, if we read the other side of the equation, *the putrescible organic matter of the sewage is oxidised*, and so great good is done. In my experience I have found that the application of sulphate of iron to sewage of ordinary freshness such as that presented at the outfall of most sewage works, and such as could be presented at all outfalls if the sewerage arrangements were good, sulphide of iron is not formed, and only in the instance of putrid sewage is this black, but inodorous and insoluble compound produced.

This production of sulphide is due to the reaction of the sulphide of ammonium or sulphuretted hydrogen present in the decomposing sewage upon the iron salt introduced, and not to the reduction of the sulphate by deoxidation.

If sulphate of iron be added to a tank of fairly fresh sewage, no sulphide is formed, but the molecular constitution of the albumenoids present is broken up, and putrefaction is prevented. The iron finally precipitated is ferric oxide, and the sulphur probably separates as such, at all

events, no volatile or offensive compounds of sulphur are produced. I do not, for one moment, expect to get proper precipitation by iron sulphate only—that has been tried years ago and failed.

Mr. Webster says that the sulphuretted hydrogen present in sewage is entirely due to the reduction of the sulphates contained therein. In this I cannot agree with him. In my opinion the production of sulphuretted hydrogen in sewage is due to the putrefaction of organic compounds containing sulphur, and is entirely independent of the presence of sulphates.

Are the stinking sulphur gases of the intestines formed by the reduction of sulphates? If not, why look to such as the source of same in sewage? If Mr. Webster will study the action of ferruginous waters on organic matter in open streams, he will find that its effect is always most beneficial.

Furthermore, iron salts are useful reagents in sewage treatment, in virtue of a power they have of forming certain organo-metallic compounds containing nitrogen, which are carried down in the precipitate, and therefore add to the manurial properties of the sludge. Again, even in the treatment of putrid sewage, when the black sulphide is formed it is better than the volatile sulphur compounds from which its sulphur is derived. Sulphide of iron has no odour, and therefore of itself can be no nuisance, unless, indeed, it be allowed to flow into rivers, where it would be liable to decomposition with liberation of sulphuretted hydrogen. I maintain that with fairly fresh sewage sulphide of iron is not formed, and in the case of putrid sewage the disgusting odours are fixed by the formation of the unsightly, but inodorous, sulphide of iron, which precipitates, if properly managed, in the tanks with the sludge.

In using precipitants containing iron sulphate upon ordinary alkaline sewage of course a hydrated ferrous oxide is formed, and, as Mr. Webster states on page 248, "no sulphuretted hydrogen can exist when ferrous or ferric oxides are present." It appears to me to be stretching the argument against the chemical treatment of sewage, or rather it is trying very hard to account for the evident purification, when certain reagents are used to speak of "an apparent purification" produced by the dilution with water. Of course no water, excepting that derived from the sewage itself, need ever be used with the addition of any chemical reagent, so that Mr. Webster's contention as to dilution has no value.

I am pleased to see that Mr. Webster supports an opinion which I have long entertained and given expression to on public occasions—namely, that ferric oxide acts the part of a carrier of oxygen to the organic matter present.

Mr. Webster, on the occasion of his describing his electric process, has taken advantage of the opportunity to make an attack, a perfectly fair proceeding, I admit, but still an attack, upon chemical precipitants containing iron sulphate.

As a sewage chemist I claim, however, that his arguments are more in favour of than against such a precipitant and deodorant as "ferrozone."

ARTHUR ANGELL, Ph D., F.I.C.,

County Laboratory, Southampton.

THE STRIKE AT SILVERTOWN.

TO THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—As misleading statements are being circulated with reference to a strike at our Silvertown factory, we ask you to give publicity to the following particulars of wages paid by us up to September 14 last, which will be found to compare favourably with those paid for similar work in any part of England:

	Hours.	Pay.
Labourers (including yard-men and stokers)	63 ...	26s. 3d.
India-rubber departments	63½ ...	33s. 7d.
Cable, wire-covering, battery, gutta-percha, electric light, and general departments	60 ...	28s. 1d.

No able-bodied labourer employed by us received less than 4½d. an hour. The above payments do not include those

made to foremen, clerks, and skilled mechanics of various classes, who, of course, draw much higher wages.

We employ a considerable number of women and boys, who are not included in the above statement, but who are paid on a scale proportionate to that of the men.

The workpeople were practically in permanent employment, their weekly number not varying much during the year; and our workshops are large and well ventilated and lighted, and our appliances of the best.

Our factory is in the neighbourhood of the docks, and the recent strike there appears to have unsettled the minds of some of the workpeople. The majority of them, however, have been intimidated into leaving their work, having, when going to their meals, to pass through a crowd, who hissed and groaned at them and used violent language. In some cases they have been hurt, but will not give evidence lest worse should befall them.

Yesterday about 115 women, who were satisfied with their pay, left work under intimidation, and there are now about 1,600 workpeople thrown out of employment, leaving only 250 still at work.—Yours, &c.,

WM. J. TYLER, Secretary.

India Rubber, Gutta Percha, and Telegraph Works Company, 106, Cannon-street, E.C., Oct. 4.

NEW YORK NOTES.

(FROM OUR SPECIAL CORRESPONDENT.)

A Remarkable Week.

The Subways Keep Down and the "Deadly Wires" Keep Up.

Electricity in the General Press.

"Our Only Electrician" in the New York Dailies.

Newspaper Science.

"How Long will a Long-suffering People Endure this Thing?"

Science in the Magazines.

The World's Fair Project Strikes a Rock in Central Park.

The Kellogg Tower.

Edisoniana.

The Great Inventor as a Reader and a Ready Reckoner.

Long-Distance Incandescent Lighting.

NEW YORK, September 28, 1889.

The past week has been an exceptional one as regards electrical matters; there has been no subway explosion, and no victim of the "deadly wires" has afforded matter for a sensational column of exaggerated nonsense in the daily press.

The subways continue to occupy attention as the authorities have decided in future to demand a money deposit from the subway company when a permit is granted to open the streets for new work, the deposit to be held by the Commissioner of Public Works until the paving has been relaid to the satisfaction of that functionary. The Subway Commissioners are of opinion that explosions in their domains will only be prevented by striking at the root of the evil, and suggest legislation which shall give them power to enforce the proper construction of the gas mains in order to do away with the immense amount of leakage, which at present amounts to 10 per cent. of the total quantity of gas manufactured.

The amount of matter published in the general press on electrical subjects affords striking evidence of the now widespread interest in electricity, and the general desire for fuller information as to the methods employed in the countless applications of that potent factor of civilisation. The daily press cannot be complimented either upon the sincerity or the accuracy of its efforts in this direction. Last week all the papers published a telegram from London giving an extract from a paper read by Mr. W. H. Preece before the British Association, in which he said that it was impossible to get a current of sufficient intensity to kill a man with certainty, and that "the sensational reports published in newspapers about people being killed by shocks from electric wires had, upon investigation, been found to be nonsense." Although Mr. Preece's meaning was perfectly clear to any electrician, and in accordance with the views of most, the last sentence of the telegram aroused the ire of the sensational reporters, and in every paper the telegram was printed under an attractive head-line, such as "An English 'Electrician' on Execution by Electricity," "England's Doubting

Thomas," "Astonishing Ignorance," "A Badly Informed English Electrician."

Another bright example of newspaper electricity is the following extract from an editorial in a leading New York evening paper: "The same night, all of Fifth-avenue above Fourteenth-street, was in Cimmerian darkness, while overhead the fierce electric current, clogged at some point in its circuit, throbbed and spluttered, endangering life and property along every foot of wire, for the parting of the current at any point would have dealt death and destruction in every direction. How long will a long-suffering people endure this thing, and how many more lives must be sacrificed to the lightning demon before an aroused public sentiment will lay the deadly parallels where they are laying so many human beings?" The italics are my own, as the passage is too distinctly precious to be printed otherwise. It is a relief to turn from such ignorant, prejudiced rubbish to the excellent articles on electrical subjects in *Scribner's Magazine* and *Harper's Weekly*. The latter journal has followed up Mr. Wheeler's masterly article on the electric light by a sketch of the electric railway industry, which, although apparently not compiled by an "electrical expert," affords the untechnical reader a clear insight into the history and development of this branch of electrical work. The railway articles which recently appeared in *Scribner's* are to be published in book form this fall, and the same will probably be done with the electrical series, and they will undoubtedly make a capital popular treatise on the recent progress in some of the more important applications of electricity.

The 1892 World's Fair project is hanging fire somewhat, chiefly on account of the difficulty in the selection of a suitable and convenient site. The Committee on Site made public their selection last week, and when it was found that part of Central Park was included great opposition broke forth. The Park Board have promised to do all in their power to prevent any part of the park being used for the fair, and several of the papers also oppose the scheme. Although the opposition seems to be in the minority, and although contributions are flowing in in large sums, it would not be surprising if the discussion and delay were to result in the fair being secured by Chicago instead of New York as the Chicagoans are pushing the matter with the greatest vigour, and there no dissensions exist as to a suitable site; in Chicago there seems to exist an *embarras de richesses* in that direction, while in New York the question of site is a difficult problem, and one on which the whole project, as regards New York, bids fair to go to wreck.

Plans are being prepared of a monster tower for the World's Fair. The tower is to be 1,200ft. high, and is estimated to cost about £400,000; it will be 350ft. in diameter at the base and about 100ft. at the summit. The framework is to be of seamless steel pipe, and it is proposed to employ triple-plate glass to fill in the sides. If this can be used, the tower will have the appearance of a gigantic crystal palace. Three different sets of elevators will be provided to carry visitors from the ground to the summit of the tower. The designer is a Mr. Kellogg, superintendent of the iron tube works at Findlay, Ohio.

The visit of Mr. Edison to Europe, and the highly flattering reception accorded him wherever he has gone, have attracted a good deal of attention both on the part of the technical press and the decidedly untechnical. A leading electrical paper, noted for its enterprise, concludes this week the publication of a lecture on "Edison and his Inventions at the Paris Exhibition," by W. J. Hammer. This description of Edison's most important productions has run through five numbers, and is very interesting reading, deriving additional value from the excellent illustrations which accompany the text. The daily papers have chronicled all Mr. Edison's doings in Paris, Berlin, and London, and have also launched out into various descriptions of the manner in which some of his discoveries were made, and of his personal characteristics and attainments.

From the account of a recent interview with one of Mr. Edison's intimate associates, we learn that "he has delved into all fields of literature, and has been all his life a great reader, or rather devourer of books on almost any subject, and he possesses the rare quality of mind of assimilating

the essence of what he reads and rejecting the non-essential; his reading has been of a catholic range, and he can hold his own with any book reader in the land. His memory is phenomenal. Indeed, it is a byword in the laboratory that 'Mr. Edison never forgets anything.' Names, dates, abstract mathematical formulas and rules alike find a lodgment in his brain are on hand at all times ready for instant use."

The reduction of degrees Fahrenheit into degrees centigrade does not involve the use of any "abstract mathematical formula," yet when Mr. Edison, while giving evidence in the Kemmler enquiry case, was asked how many degrees centigrade 60deg. Fah. were equivalent to, after some consideration, he was obliged to give it up, and get Mr. Kennelly to supply the answer!

Two central stations in the West, for the supply of current to incandescent lamps at long distances, have recently attracted attention. One is at Englewood and the other at Ottawa, both towns in Illinois. The Englewood station uses the Westinghouse alternating system; a start was made 10 months ago with one 750-light machine, but the demand was so great that a second machine of 1,500-light capacity was soon added, and very shortly a third dynamo of the same output will be installed. The station is an annex to a large planing mill, and the electric light machinery is run by the steam plant of the mill. The fuel used is of a very economical nature, consisting, as it does, of sawdust and shavings, which are deposited in a vault in front of the furnace by a system of fans and blowers that convey the shavings along iron pipes leading from the different machines; from the vault, the fuel is shovelled direct into the furnace. Over fifteen miles of wire are used on the outside circuits. The residences lighted are scattered over a large territory and some of the lamps are two and a quarter miles from any others; additional circuits are now being constructed which will ultimately carry current to twice that distance. The current is supplied by measurement, and the system works satisfactorily; so far the customers have not complained of any eccentricity on the part of the meters. The other station mentioned supplies light to Ottawa, but the station is situated at Marseilles, a town eight miles distant, where ample water power is available to run the dynamos, which are of the Heisler long-distance incandescent system. The trunk lines are built of No. 8 American gauge copper wire, insulated with waterproof covering. Over 45 miles of circuits have been erected, including some 12 miles of No. 11 wire. The first lamp is in Ottawa, distant some eight miles from the station. The plant was only very recently completed, but the first dynamo is now carrying a full load. The lamps furthest from the station are said to burn as brightly as lamps placed near to the dynamos. In a short time this station will be operating lights in four different towns, three of them being five, eight, and 10 miles respectively distant from the centre of the system.

ADDRESS TO THE MECHANICAL SCIENCE SECTION OF THE BRITISH ASSOCIATION.

BY WILLIAM ANDERSON, M.I.C.E., PRESIDENT OF THE SECTION.

(Continued from page 258).

The practical importance of the views I have enunciated are, I think, sufficiently obvious. Everyone will admit that an external force cannot be applied to a system in motion without affecting that motion; consequently, matter, in whatever state, cannot be touched without changes taking place, which will be more or less permanent. The application of heat will cause a change of volume, and, at last, a change of condition; the application of external stresses will also produce a change of volume; and it is natural to infer that there must be some relation between the two, and, accordingly, Prof. Carnelley has drawn attention to the fact that the most tenacious metals have high melting points, though here again there is a great want of exactness, partly on account of the difficulty of measuring high temperatures, and partly by reason of the scarcity of pure materials.

Again, long-continued stresses, or stresses frequently applied, may be expected to produce permanent changes of form, and so we arrive at what is termed the fatigue of substances. Stretched beyond their elastic limits, which limits I do not suppose to

exist except when stresses are applied quickly, substances are permanently deformed, and the same effects follow the long application of heat. The constant recurrence of stresses, even those within the elastic limit, causes changes in the arrangement of the particles of substances which slowly alter the properties of the latter, and in this way pieces of machinery which theoretically were abundantly strong for the work they had to perform, have failed after a more or less extended period of use. The effect is intensified if the stresses are applied suddenly, if they reach nearly to the elastic limit, and if they are imposed in two or more directions at once, for then the molecular disturbance becomes very intense, the internal equilibrium is upset, and a tendency to rupture follows. Such cases occur in artillery, in armour-plates, in the parts of machinery subject to impact, and, as might be expected, the destructive effects do not always appear at once, but often after long periods of time.

When considerable masses of metal have to be manipulated by forging, or by pressure in a heated condition, the subsequent cooling of the mass imposes restrictions on the free movement of some, if not all, of the particles. Internal stresses are developed which slowly assert themselves, and often cause unexpected failures. In the manufacture of dies for coining purposes, of chilled rollers, of shot and shell hardened in an unequal manner, spontaneous fractures take place without any apparent cause, and often after long delay, the reason being that the constrained molecular motion of the inner particles gradually extends the motion of the outer ones until a solution of continuity is caused.

Similar stresses occur in such masses as crank shafts, screw shafts, gun-hoops, etc. The late General Kalakoutsky, some 17 years ago, commenced a systematic investigation into the internal stresses in the tubes and hoops of guns, and in armour-piercing shells. The method he pursued was to cut discs or rings about half an inch thick off the hoops and shells, to divide the metal of each disc into from four to six rings, to fix by means of silver plugs, on which very finely-marked cross lines were drawn, from four to eight points on the surface of each ring, and then to measure, with extreme exactness, the changes in diameter produced in every ring by the successive cutting out of the rings. Knowing by direct tests the mechanical properties of his material, he was able, from the changes in the diameters, to calculate what the tangential stresses in every part of each disc were, and to draw inferences as to their fitness for the work they were intended to perform. The same method of investigation has been pursued by Captain Noble, of the Elswick Works, and by Lieutenant Crozier, of the United States artillery, with the practical result that probably much more attention will be paid in future to the principles on which the annealing and hardening of steel is carried on. A gun hoop or tube, to be in the best condition to resist a bursting stress, should have its inner surface in a state of compression, and its outer in a state of tension, and the hoops should be shrunk on to the tubes or on to each other with but very little pressure. General Kalakoutsky proposed, in order to set up beneficial internal stresses, the tubes which were being annealed should be cooled from the inside by a jet of steam, of air, of water, or of oil; and he advocated the practice of testing the effects of each new method of manufacture or of treatment by the careful measurements of slices of the finished material instead of working at random, as is still very much the practice. It is evident, also, that a sample of steel cut out of a gun-hoop or crankshaft, and tested, can afford no indication of the available tenacity of the same sample *in situ*. When released from the constraint of its surroundings, the particles must, of necessity, change their condition, for the disturbing forces have been removed; and the probability is that, if the steel be good, the test will prove satisfactory, especially if some time be allowed to elapse between cutting out the sample and testing it, and a false security will be engendered such as has often led to disastrous results.

The influence of time on steel seems to be well established; the highest quality of tool steel are kept in stock for a considerable period; and it seems certain that bayonets, swords, and guns are liable to changes which may account for some of the unsatisfactory results which have manifested themselves at tests repeated after a considerable interval of time. As all these things have been hardened and tempered, there must necessarily have been considerable constraint put upon the freedom of motion of the particles. This constraint has gradually been overcome, but at the expense of the particular quality of the steel which it was originally intended to secure.

I have now laid before you the views respecting the constitution of matter which, I think, are gaining ground, which explain many phenomena with which we are familiar, and which will serve as guides in our treatment of metals, and especially of alloys, but I must admit that the subject is still by no means clear, that a great deal more definition is wanted, and that we are still awaiting the advent of the man who shall do for molecular physics what Newton did for astronomy in explaining the structure of the universe.

(To be continued.)

ELECTRICAL TRANSMISSION OF POWER IN MINING OPERATIONS.

BY ALBION T. SNELL.

When considering the application of a new means of transmitting power for mining purposes, it seems almost necessary to make some allusion to the steam-engine. Indeed, if the steam-engine does not owe its origin to the necessities of mining, yet, perhaps, most of the fundamental improvements were worked out in mining engines, and oftentimes by men directly connected with mining industries. Savery's engine was primarily used for pumping mines; and Newcomen, a Devonshire man, especially designed his "Cornish" engine for draining the metalliferous mines of Cornwall. Watt and Boulton applied their "fire-engine" to similar purposes. And George Stephenson, the son of a fireman at a Northumbrian colliery, worked himself as gin-boy, fireman, brakesman, and engine-wright, and spent his earlier years entirely amongst collieries. Since then the steam-engine owes so much to the mining industry, it is not surprising to find mining engineers taking a deep interest in the progress of electricity. Indeed, it is with no little pride we find the well-known name of Locke as one of the first users of electrical plant for mining purposes in this country. The more so as the Normanton plant was when erected, and still is, the largest electrical power plant in Great Britain above or below ground. We must also remember that perhaps the first underground electric pump was erected by a free miner of the Forest of Dean, Mr. F. Brain, and I venture to think that the pluck shown in thus over-riding existing notions has been well repaid. In comparing the introduction of steam and electricity, one cannot but note the different rates of progress. It took more than 60 years to develop the vacuum cylinder of Savery into the double-acting condensing beam engine of Watt and Boulton. And most of the improvements of the two Stephensons were not made before the early part of the present century. The first practical electric motor was made by Jacobi in 1834, but the motors remained little more than mere toys till the introduction of the Gramme dynamo in 1870, and then the transmission of power by electricity became a commercial possibility. By 1880 motors had received considerable attention, and marked improvements had been made by the late Dr. Werner Siemens and others. For some years now, machines of all sizes have been designed with ease and certainty to fulfil the varying requirements of our industries. It is worthy of note, too, that the efficiency of conversion obtained is so high that there is practically no room for further advance in this direction. The motor returns about 85 per cent. to 94 per cent. of the energy supplied to it, and the theoretical limits are obviously almost reached. This rapid progress in electricity is due to the splendid ability of our scientists and the mechanical genius of our engineers, rather than to the simplicity of the subject. Something, perhaps, is also due to the peculiar fascination electro-technics seem to exert over the student. There is a certain charm about dealing with what we cannot see and can only partly understand, but what is always obedient to fairly well defined laws. Be this as it may, the combined efforts of the scientist and the practical man have reduced the problem very nearly to its lowest terms, and now a 50 h.p. motor can be handled more easily than a steam-engine of the same power. I have compared the introduction of the steam-engine and the electric motor, but we must not confound the functions of the two. The steam-engine is essentially a prime motor, coal being the source of energy. Electricity, as considered here, is a medium by which energy is transmitted from one place to another. It is not a source of independent energy. In this paper it will be understood that the prime motor of an electric power plant is assumed to be a steam-engine, or a water-wheel, or other machine deriving its energy from the combustion of fuel or kinetic energy of matter. Having, then, defined what we understand by an electrical plant, we will see what constitutes its essential component parts. Primarily, our object is to transmit energy from a point where it can be cheaply generated to a point where it can be usefully spent. There are several well-known ways of doing this. The simplest plan is probably a rigid connection between the prime shaft and the point of application of power, as in the pump-spear of a Cornish engine. A wire rope can be used in a similar way, either with a reciprocating or a continuous motion. And this method has the advantage of flexibility, and the path is not necessarily straight, or nearly so. Indeed, this plan has deservedly met with no little favour of late years. Or, again, we can use steam, compressed air, water, or electricity. Each of these six methods of transmitting energy possesses certain advantages peculiar to itself; and consequently each will be more or less adapted to any particular case. It is not proposed here to examine the relative advantages at length. We will only note, as an axiom, that where the power can be applied directly, a positive method gives usually the best results as regards first cost, economy, and durability. It is, however, apparent that if the energy is to be transmitted any distance a flexible connection is desirable; and if the distance be considerable, that steam will be out of the question, under existing conditions of pressure. Indeed, the matter will resolve itself into a choice of rope, water, compressed air, or electricity. The rope system, although comparatively cheap at the outset, is costly to maintain, and the plant efficiency is low. By plant efficiency, I here mean the ratio between useful work and total work. Hydraulic transmission has certain advantages, which, however, seem to be more apparent than real. If there be sufficient head of water to give the desired power without using steam, and the waste water can be got rid of without much cost, then this method would appear to be commercially the most efficient possible, and in many cases it is so. But it must not be forgotten that if the power water has to be itself raised after parting with its energy, that the efficiency of the system is very low, yet commercially this consideration may be over-weighted. I

* Lecture delivered before the Mining Engineers at Wigan.

know of several hydraulic plants with so low an efficiency that they are only tolerated because the power water costs nothing. If we add to the low plant efficiency, the wet resulting from leakage, and the amount of attention required by high-pressure plants, there will be but few advantages in most cases of colliery hydraulic work. Practically, then, in cases of transmitting energy over long distances the battle seems to lie between compressed air and electricity. My opinion in this matter is guided by a considerable acquaintance with mining engineers in all parts of the English and Welsh coalfields. It appears, as far as my experience goes (and American experience agrees), that electricity will be both cheaper and more reliable than compressed air, and it certainly is capable of a far higher commercial efficiency. Of course, we must not overlook the advantage of the cool exhaust in certain deep and badly ventilated mines. But it seems to me to be cheaper to ventilate a mine by a compound fan-engine, giving at least 50 per cent. efficiency, than to rely on a compressed air plant returning about 20 to 25 per cent. only. Before discussing, then, the electrical plant, we will note again that each system has its own peculiar advantages, which, in particular cases, will make it the best. The engineer must bear in mind that a machine is good or bad as it does its work well or indifferently, and local circumstances will so influence his decision that one method cannot be said to be absolutely superior to another. We have made this brief digression from the main subject so as to clearly see what we propose to do by electricity, and how we should compare it with other means of transmitting energy. We have defined electricity as a means by which energy can be transmitted, and have roughly scanned the methods usually employed in mines for conveying power from one point to another. We must now note that an electrical plant consists really of four essential parts. The first is the steam or water plant used to drive the dynamo. The second is the dynamo, in which the steam power is converted into electrical energy. The third is the conductor, by which the current is carried from the dynamo to the motor. The fourth is the motor, which reconverts the electrical energy into mechanical work. The motor is then simply a machine capable of giving so many h.p., and may be coupled to any required work by the ordinary methods—by belting, gearing, or otherwise. We see in the details of an electrical plant a striking likeness to the parts of a compressed air one. In both we require a prime source of power, usually a steam-engine. In both we make a double conversion of energy. The dynamo finds its counterpart in the compressors, and the motor in the air-engine. And in both systems there are means of conveying the energy between the two converters. The electrical conductor has its analogue in the air pipe. In one point, however, the two plants differ. The dynamo regulates the output of electricity to suit the requirements of the work without any accumulator, the air plant requires a receiver to store up energy against sudden demands. Seeing, then, how these two systems are related with reference to their several parts, we are not surprised to find them brought into close contest for the same work. It would be interesting to compare them step by step from the prime motor to the effective work done; but space is too short, and we must content ourselves by a brief comparison when we come to the practical application of electricity. Strictly speaking, it is not necessary to understand the principles of the motor in order to successfully work an electrical plant; but I think that a few words of explanation with reference to the conversion of energy will not be uninteresting. For our purpose, then, the motor may be considered as the converse of the dynamo. The rotation of the dynamo armature converts mechanical energy into electrical; and electrical energy supplied to a motor causes a rotation of the motor armature. In each case the phenomenon is traced to magnetism. In the dynamo we are continually doing work against the attraction produced by magnetism, and in the motor the magnetism induced by the current of electricity causes rotary motion. The action will be readily understood by considering two bar magnets placed in the same plane, one being fixed, and the other free to rotate about an axis at right angles to the plane and coinciding with its centre of gravity. The units in which electrical quantities are measured have so often been mentioned, that one feels it necessary to apologise for again introducing them. However, there seems to be some difficulty amongst mining engineers in grasping the significance of the electrical nomenclature. And, further, several of the technical papers read before mining institutions have been very badly reported. We will, then, at the risk of recapitulation, briefly examine the relation between the electrical and the mechanical terms. The practical electrical units, the volt, ampere, and ohm are connected by the equation

$$C = \frac{E}{R}$$

Where C is expressed in amperes, E is expressed in volts, and R is expressed in ohms. These quantities are severally certain numbers of units of quantity, pressure, and resistance. The first two are measured directly by simply reading suitable instruments placed in the circuit; and their product, $C \times E$, gives us the rate at which electrical work is being done. This rate is measured in units, called watts. Now, 746 watts are equal to 1 h.p. The ratio between the watt and the horse-power is thus, 1 : 746. If we then divide the product of amperes and volts by 746, we shall have the electrical work done in the circuit expressed in the familiar terms of horse-power. The watt and the horse-power are thus quantities of the same order. They both express certain rates of doing work, and hence can be converted into similar terms.

The horse-power = 33,000 ft. lbs. per min.
or 550 ,, ,, ,, sec.

And since the ratio of the watt to the horse-power is 1 : 746 :

The watt = $\frac{33,000}{746}$ = 44 ft. lbs. per min.
= 733 ft. lbs. per sec.

I have demonstrated this at length in order to show clearly that the electrical horse-power is really the same as the mechanical horse-power. If desirable, we can thus express electrical output in horse-power. It is only necessary to read the amperes shown on the ammeter, and the volts indicated by the voltmeter, to multiply the product of these two quantities by 44, and we have the number of foot pounds per minute done by our dynamo. It is usual, however, to divide the quantity $C \times E$ by 746, and thus estimate the electrical work in horse-power. We now are in a position to understand the terms of an electrical problem, and to express it in proper units. It will be profitable, before describing actual work, to examine a little more in detail the several parts of the electrical plant. The prime source of power needs only to be touched upon, since it is common to all systems. We only note that since the commercial efficiencies of the dynamo and motor are greater than those possible in the compressor and air-engine; for a given quantity of work the electrical plant will require the smaller prime motor. The dynamo is the first point which demands our especial attention. You are all fairly well acquainted with the general form, and we have already discussed the elementary principles of the subject; it only remains to see some of the conditions appertaining to the successful running of these machines. Primarily, we require a clean dry house, and a fairly steady-running engine; essentially, this is all, and the dynamo will give a maximum of work for a minimum of attention. I know of no converter of energy so easy to handle or requiring so little attention. The same remarks will apply to the motor, but special stress may be laid on the compactness and large output for a given weight. One h.p. can be obtained for about 70 lb. of material in cases where weight is an object. In ordinary mining practice, however, an output of one h.p. for every 100 to 120 lb. is generally preferred. There remains then the conductor, or cable connecting the dynamo and motor. Essentially, this is of metal, and the circuit must have metallic continuity. Theoretically, the kind of metal does not affect the problem if sufficient cross-section be allowed; indeed, this is rather a matter of cost and convenience. In practice, only copper and iron are in general use. Copper has about seven times the conductivity of iron, or is seven times as good a conductor of electricity. If we use copper, then, for the cable, we only require one-seventh the cross-section that would be necessary with iron for the same loss in transmitting a given quantity of energy. Bare copper wire does not, at the usual market prices, cost much more than iron cable of seven times the area, and is, further, less bulky and cheaper to erect, so in most cases, where bare conductors can be used, copper obtains the preference. With covered or insulated wires copper is universally employed, since the smaller bulk requires less insulation. You will thus see that the choice of the conductor depends principally on the question of prime cost. If, however, a high electrical pressure is employed, as at St. John's Colliery, we are compelled to use a high-class insulated cable, with a copper conductor, not so much owing to the cost as to the necessity of presenting a high resistance to leakage of the current. We may note here that electricity is always trying to shorten the path between the positive and negative brushes of the dynamo. There is no such thing as absolute insulation in practice, and hence a certain quantity of the current is always wasted. The amount is negligible in a good installation, being a fraction of 1/10 per cent. at the most. It varies directly with the pressure, and inversely with the insulation resistance, hence the necessity for good insulation in large power plants. We have now seen the general conditions that determine the character of the conductor and its insulation. We have next to ascertain the probable loss of energy in the cable itself. You will remember that the efficiency of the conversion of the dynamo and motor for medium size machines, may be taken as averaging 90 per cent. Hence, if there were no loss in the conductor, the ratio between the work done by the motor and that on the belt of the dynamo would be about 80 per cent. It is clear though, in the nature of things, that energy cannot be transmitted by the cable without some loss. Fortunately, the law which regulates this loss is very simple, and can be learnt by a little consideration. The horse-power lost in a conductor carrying an electric current is equal to the square of the current in amperes, multiplied by the resistance in ohms, and divided by 746. We have seen how the current can be measured by an ammeter. We have then no difficulty with the first term. The resistance is not a simple thing to measure directly without proper instruments; but it can be taken approximately from any of the wire manufacturers' tables, if we know the gauge. We must note, however, that the resistance of a given wire is directly proportional to its length. This we are led to expect from the mechanical analogue of air or water friction in pipes. Also the resistance is inversely proportional to the area of the conductor, or a wire of one square inch cross section has one-half the resistance of one only half a square inch. This is also comparable with our experience in hydraulics. We now see that the laws regulating the loss in the conductor are sufficiently simple in most cases. We note that the loss in horse-power, for given quantity of energy transmitted, with a given current, through a given conductor, varies directly with the length of the conductor—i.e., twice the distance between the dynamo and the motor. In practice the problem usually presents itself this way. Given a certain distance between dynamo and motor, determine the best size of cable to transmit a definite quantity of energy. This, although not difficult, presents several practical points which somewhat complicate the simple theory, and we cannot discuss it here. But sufficient has been said to show the sound engineering basis on which the determination rests. To give some idea of the magnitude of the loss to be expected in the cable we will refer to the Normanton plant. The conductor is about 1,000 yards in length, and is composed of 19 strands of No. 16 B.W.G. copper wire. The energy transmitted is roughly 50 h.p., and the loss is approximately $2\frac{1}{2}$ h.p., or 5 per cent. If the cable were one mile in length the loss would be about 8.75 per cent.

TABLE A.

Work.	Volts on dynamo.	Amperes.	E.H.P. given out by dynamo.	Indicated h.p. of engine.	Efficiency.
Pumps running 24 revs. and delivering 117 gals. per min. 890ft. high. (=31.5 h.p.)	605	62	50.2	73.0	$\frac{31.5}{73} = 43.1$ per cent.
Columns run off, and suction clack lids open engine, dynamo, leads, motor and pumps. (Friction.)	410	27	14.8	28.6	
Engine, dynamo, leads, and motor. (Friction.)	No register.	No register.		18.4	
Circuit open, engine and dynamo. (Friction.)				11.7	
Belt of dynamo and engine only. (Friction.)				6.9	

Up to this point we have been discussing the conditions which govern an electric power plant; we will now proceed to the description of some actual installations. I will first mention a few cases designed by me in conjunction with colliery engineers, and carried out by Messrs. Immisch and Co. *Normanton Pumping and Hauling Plants.*—I will first refer to a small pumping plant erected at St. John's Colliery, Normanton, in August, 1887. Mr. Warrington, of Messrs. Locke and Co., has kindly allowed me to give the following details: The pump delivered about 39 gallons per minute through 530 feet head. A very complete test of this plant was published in the mining journals about November 18th of the same year. I have given the figures in appendix I. for comparison with tests of later plants. The results obtained were so satisfactory that Messrs. Locke and Co. decided to put down a larger plant, to deliver 120 gallons per minute through 900ft. of vertical head, and I was entrusted with the design of the machines. This large plant was started in February of the following year, 1888, and has continued running about 22 hours per day since then. The run now exceeds 18 months, and during that period there have been no breakdowns traceable to the electrical details, all stoppages being due to mechanical defects, incidental generally to the engine or pumps. The plant has been described before, but not in detail. I now propose to give results of tests made by the colliery engineer, Mr. E. Brown, and myself. The engine is of the semi-fixed type, by Robey and Co., of Lincoln. It is compound, and is rated by the makers at 30 nominal h.p. It has indicated during the past 18 months on an average about 80 h.p. The dynamo is driven off the flywheel by a link belt 14in. wide, curved to fit the pulley. The belt speed is about 3,750ft. per minute. The dynamo is designed to give 600 volts and 70 amperes. The motor is of similar design to the dynamo, but the field magnets are of lighter construction. The pumps are differential, with two 6in. and two 4½in. rams. The suction is made by the two large rams only. On the in-stroke the 6in. rams deliver water partly into the rising main and partly into the small rams. On the out or suction-stroke the 4½ rams deliver into the column, and so the discharge is fairly continuous. When doing full duty the pumps make 25 revs. per minute. The rising main is about 450 yards long, and is composed of 4in. cast-iron pipes. An air-vessel about 5ft. high is fitted at the lower end near the delivery clacks. The piping is undoubtedly too small for 120 gallons per minute. It was really designed for a feeder of about 50 gallons. The water travels in the column at about 250ft. per minute, and there is nearly 10 h.p. lost in friction. This heavy loss is against the total efficiency of the plant, and an allowance can be made if anyone thinks proper. The cable is built up of 19 strands of No. 17 B.W.G. copper wire, insulated and lead covered. It is about 1,000 yards long, and has a resistance of about .5 of an ohm. About one week after the erection in February, 1887, the electrical quantities for the full load averaged about 65 amperes and 603 volts, with 450 revolutions of the dynamo and 134 revolutions of the engine per minute. The motor run at about 450 revolutions per minute, and the pumps at 25 revolutions. Under the above conditions the water delivered was measured, and found to be between 118 and 120 gallons per minute. The suction has a rise of about 14ft. and the column is 860ft. in vertical height. Thus the theoretical horse-power in the water is about 32. The engine was indicated at the same time and found to be giving 80 h.p. The efficiency of the system, that is the ratio between theoretical work in the water and i.h.p. of engine, was therefore equal to $\frac{32}{80} = 40$ per cent. These tests have been repeated from time to time by various gentlemen, and the readings show a gradual decrease of the losses due to friction, particularly in the engine and pumps. A log has been kept, and the daily readings of current show a steady fall. At the last test, Mr. E. Brown found the current had fallen to about 62 amperes, and the engine only indicated about 73 h.p. The efficiency had thus increased to about 43 per cent. The figures of the tests are shown in Table A (above).

The percentage of losses, as calculated from the indicator cards are:

Engine friction.....	= 6.9 h.p. = 9.4 per cent.
Belt and dynamo friction.....	= 4.8 " = 6.5 "
Leads and motor.....	= 6.7 " = 9.4 "
Motor, belt, gearing, and pumps empty.....	= 10.2 " = 14.0 "
Load of 117 gallons through 890ft.....	= 31.5 " = 43.1 "
Water friction in pumps and rising main.....	= 12.9 " = 17.6 "
	73.0 100 "

The engine doing above load indicated 73.0 h.p. The friction of the water in the pumps and rising main is arrived at by subtracting the sum of the theoretical horse-power in the water delivered, and the total friction from the total i.h.p. of the engine, or $73 - (31.5 + 28.6) = 12.9$. This is not quite correct. The friction diagrams are necessarily taken with no load on the pumps, and hence are all slightly lower than is actually the case when the load is on. From the known efficiency of the motor, the loss in the pumps and rising main has been found to be not less than 10 h.p. The coal consumption of this plant was so much less than that which obtained with the compressed air plant, formerly used for the same work, that at my suggestion careful tests were made of the air plant efficiency. The conditions were singularly favourable for comparison. The superseded air-engine was still in position, and could be coupled to the same pumps. There were also two sets of compressors—a pair of horizontal compressors 20in. by 4ft. and a large vertical one. These were each put to drive the pumps, but since the pressure obtainable was only sufficient to raise the water about 530ft. the column was tapped at the Stanley Main seam. Tests of the electrical plant delivering to the same place were also made, with the following results. The horizontal compressors gave a net result of 12 per cent., and the vertical one gave a little over 14 per cent., while the electrical system returned 44.4 per cent. The figures of the latter test are as follows:

Work.	Volts on dynamo.	Amperes.	E.H.P. given out by dynamo.	Indicated h.p. of engine.	Efficiency.
Pumps running at 8 revs. and delivering 39 gals. per min. to "Stanley Main," 530ft. = 6.3 h.p.	171.0 173.4	47.5 47.5	10.9 11.0	14.2	$\frac{6.3}{14.2} = 44.4$
Pumps at normal speed with suction clack lids open and column run off.	128 127	28.0 26.0	4.82 4.45	6.3	
Motor and first shaft only running approx. at normal speed.	111 105	20.0 20.0	2.96 2.80	4.8	
Dynamo running at normal speed with circuit open.				1.715	

These last tests were all made by the colliery engineer, Mr. E. Brown. The results obtained were so satisfactory that the pumps were at work only a fortnight before Messrs. Locke and Co. gave an order for a duplicate set of electrical plant, intending to use the new machines for both hauling and pumping. The pair of 20in. by 4ft. compressors were removed, and foundations were laid in their place for the two dynamos; the old air compressing engines 20.5in. by 4ft. being arranged by suitable gearing to run them. At the same time a set of three throw rams, 6in. bore by 12in. stroke, were specially designed for dealing with the water. This new plant was nearly all finished and delivered at the colliery by the early part of the present year; but press of circumstances prevented the starting of the engines till late in July. The new dynamo, motor, and pumps show a further decrease of power for the same work. The quantities average about as follows: Engine 50 revolutions per minute; dynamo 480 revolutions per minute, 690 volts, and 59 amperes; motor 450 revolutions per minute; pumps 34 revolutions per minute; water delivered about 125 gallons per minute. The arrangement of the motor-house is very complete. A main shaft is run through the three houses, containing the two pumps and the hauling gear. This shaft is fitted with clutches, so that either motor can be coupled to either of the pumps or the hauling sheaves; or both motors can be coupled to the shaft, and all or any of the machines attached. It is a most convenient and efficient arrangement, and prevents a trivial accident resulting in a serious stop to the mine. The following are the particulars of the endless rope haulage: The main or belt rope makes three turns round the main driving sheave, and then, passing round a tightening sheave, is led through a short tunnel to the main road. Here it gives motion to two horizontal sheaves, making about two and a half turns round each. These sheaves are coupled to two endless ropes by friction cones worked by screw gear. The main rope is kept running at the desired speed, and the two working ropes are started and stopped as necessary. The main rope is 1in. in diameter. The working ropes are both ¾in. They are all made of crucible steel. The sheaves are all about 4ft. 4in. in diameter over the iron lagging. The coal now delivered is about 400 tons per day of eight to ten hours, the "Haighmoor" rope only being used. The motor is running at about half the arranged speed, and is doing less than half its designed output. The

"Kirkthorpe" rope will be put on next week. Even with this additional load of some 300 tons per day there is an ample margin for future increase of output. The arrangement could easily deliver 1,000 to 1,200 tons per day if necessary. No difficulty of any kind has been experienced with the hauling details. The ropes work with the regularity of clockwork, maintaining an almost constant speed whatever the load may be. The dynamo and motor are running most satisfactorily; indeed, without looking at the ammeter it is hardly possible to say whether the working rope is on or not. Exception may be taken to the tests of these air plants, on the score of the compressors being old and out of order. Indeed, I admit that the efficiency should be nearer 20 per cent. with plants of modern design in good order. To show, however, the efficiency to be expected from such a plant, I give the following test of a first-class American air system for transmission of power: *Test of Compressed Air System for Mining Plant at the Chapin and Ludington Mines, Iron Mountain, Michigan.*—At the Quinnesee Falls of the Menominee River, about three miles from the mines, there are four turbines, one of 1,000 and three of 900 h.p. each. Each turbine runs a pair of compressors. The air is compressed to about 60 lb. at 60 deg. F., and is carried to the mines in a 24 in. iron pipe, made in lengths of 68 ft., with expansion joints every 10 lengths. The power is applied at the mines by supplying the air to Corliss engines for running Cornish pumps, hoists, etc., and is also applied direct to the rock drills, and to the pumps, and to a Corliss engine running tramway cable underground. The total cost of the plant is estimated at about £100,000. A test made February 20th, 1888, shows the following results: i.h.p. of compressors 1,430.27, sum of i.h.p. of engines at mines 390.17. Therefore only 27 per cent. of the h.p. indicated by the compressors is recovered as i.h.p. in the cylinders at the mines. Number of cubic feet of air at compressors in 11 hours 1,231,736, number of cubic feet of air at engines in 11 hours 967,391, loss 264,345. The loss of pressure between compressor and engines is about 2 lb. In these figures we see that the loss is nearly 75 per cent. This includes the losses due to the leakage, and loss of energy in the form of heat, but does not include friction of engines or compressors, so that the total loss between the point of application of power of the turbines, and the point of application of power of engines to shafts, etc., cannot be less than 75 per cent. of total (probably 80 per cent. or more, I think). In other words, the efficiency of the system, stated as would be stated in an electrical system, does not exceed 25 per cent. The figures above are a fair example of tests, which are made at regular intervals." I venture to think that an electrical plant, to give an effective return of 390 h.p. on the shafts, etc., at the mines, would in this case have not cost more than £60,000 at the outside. [Extract from a paper by Mr. R. P. Rothwell, in the *American Engineering and Mining Journal*, January 5, 1889.] Since writing this paper Prof. Kennedy has made a very complete test of the Popp system of pneumatic transmission at Paris. His experiments strongly bear out my own more limited experience. The best efficiencies to be expected seem to be about 20 per cent. even with modern plants. *Llanerch Colliery Hauling and Pumping Plant.*—As an example of electricity applied to drive a single rope hauling engine, I will refer to a plant at Llanerch Colliery, near Pontypool, Monmouthshire. This plant has now been in use for about four to five months. By the courtesy of the owners, Messrs. Partridge and Jones, I am enabled to give the following particulars: The dynamo is driven by a horizontal engine with an 18 in. cylinder and 3 ft. 6 in. stroke, making, at full speed, about 50 revolutions per minute. The steam pressure varies between 60 lb. and 50 lb. at the main boilers, and the speed is controlled by a Pickering governor. The engine drives a countershaft by a 9 in. by 3 in. link belt, and the dynamo is run off this shaft by a similar but lighter belt. Provision is made for running a second dynamo for lighting and other purposes. The engine-house is built with sandstone quarried on the spot. The pit shaft is 250 yards deep, and the motor-house is about 750 yards in-by on the main in-take. The copper cable is composed of 19 strands of No. 18 B.W.G., insulated and covered with lead. The shaft is rather wet, and the roads are also damp; but no special trouble has been caused by this. The roofs and sides are not particularly good. The "falls" have caused some trouble with the cable; but it is fully expected that the arrangements now made will meet the case. The motor is coupled to a countershaft on the hauling-engine bed by a link belt. A pinion on this shaft engages a wheel mounted on the drum axis. The drum is thrown out of gear by a lever to let down the empties, as is usual with single rope haulage. In fact, the haulage engine is an old type machine, previously driven by a single engine, and converted for its present use by the removal of the crankshaft and cylinder. The rope is steel, and is threequarters of an inch in diameter. Two drifts are worked—one with a grade of 1:8; the other, about 1:12. They are both at present some 300 yards long; but will increase in length as the "face" recedes. The trams used are built entirely of iron. They average about 7 cwt. empty, and carry about 22 cwt. of coal, so that each loaded tram represents a rolling load of about 29 cwt. The wheels are 12 in. in diameter, and each pair is keyed to the axle. The rails are of the girder type, and weigh about 28 lb. per yard. The general condition of the road is well up to the average of colliery practice. The rolling friction, as measured by a dynamometer on a level part of the road, averages nearly 70 lb. per ton. The drift with the 1:8 grade has two "partings" in continual use at present, and hence there is a great deal of shunting, stopping, and starting. The signals are given by a "rapper," and the motor is controlled by a lever similar to the regulator in ordinary use on steam-engines. The notches correspond to different rates of motor power and speed. The trams can thus be moved a few inches at a time if necessary, and the speed can be varied from a foot per second to the desired maximum. An ammeter is placed in the circuit near the lever so that the brakeman can tell the number of trams on the rope and can also judge whether it is going right with the "journey." If, for

instance, a tram leaves the metals, the ammeter needle registers more than the maximum current for the full load; the driver at once stops the motor and brakes the drum. The tram is then set right probably before any damage is done. The power absorbed by the drum and rope averages about 5 h.p. The various horse-powers, speeds, strain on ropes, etc., corresponding to rolling loads of from one to six full trams, are given in the following tables, calculated from actual tests. The ohmic resistance of the cable is 1.25 ohms, and the energy lost for the different loads is shown in the tables. The engine has not been indicated, and so the efficiencies can only be calculated between the outputs of the dynamo and the actual work on the rope. It will be seen that the electrical losses are small. The heaviest loss is that incurred by the friction of the drum and rope. This could probably be reduced by designing special gearing. Accepting things as they are, the efficiency between the maximum work on the rope and the probable i.h.p. of engine is about 50 per cent. The strain on the rope on the 1:8 grade was measured by a dynamometer, and the result averaged for one and two tram readings. It is fairly represented by a pull of 4.5 cwt. per tram. Taking the grade as 1:8, the resistance due to gravity is 280 lb. per ton. The average resistance measured by dynamometer on the level was 70 lb. per ton. (See table B.) These figures show on inspection the high efficiency that a properly designed electrical plant is capable of. If we take the dynamo conversion at 85 per cent. and the engine efficiency at the same figure, the total efficiency for six trams (i.e., the ratio between work in the rope and the indicated horse-power of engine) will be equal to $67 \times 85 \times 85 = 48.5$ per cent. The motor is also arranged to run a set of three throw pumps. When these are running, the hauling drum is thrown out of gear. *Andrew's House Pumping Plant.*—As a good sample of dip pumping by electricity, I will refer to a small plant erected at Andrew's House Pit, for Messrs. Bower and Partners. I am enabled to give these details by the courtesy of the manager, Mr. Berkley, jun. The plant comprises two sets of three throw pumps, with suitable dynamo, etc., and is designed to cope with two small feeders, one about a mile in by, and the other rather more. The water was previously raised by two "cranks," each equipped by eight horses, working in pairs, for three hour shifts. The engine has a horizontal cylinder 12 in. by 24 in., and runs at about 38 revolutions per minute. The steam is controlled by a governor working on a throttle valve. The dynamo is shunt wound, and gives about 270 volts and 18.5 amperes. The positive cable, about a mile long, is composed of a strand of seven No. 18 B.W.G. copper wires, insulated and lead-covered. The return is made by an old iron rope about 1 in. in diameter, laid along the side of the road. The resistance of the entire cable is about 4.5 ohms. Both the motors are fitted with suitable starting and stopping gear, and are independent of each other, so that both or either pump can be run at pleasure. The delivery pipes are about 750 yards long. The quantity of water now being pumped by the two motors is about 60 gallons per minute. The lift from end to end is 44 ft., but owing to friction, etc., the effective resistance is equal to a head of certainly 60 ft. The pumps are three throw rams, 3 in. by 7 in. The speed averages 60 revolutions per minute. The plant is a very small one, but is probably the most efficient that could be used under the given conditions. It is interesting, particularly on account of the distance through which the power is conveyed under ground. One motor has been running since Whitsuntide, the other a shorter time. The plant continues to give satisfaction. *Linlithgow Pumping Plant.*—Another illustration of the application of electricity to transmitting energy through a long distance is a small pumping plant at the Linlithgow Shale Oil Works, Linlithgow. In this case one of the main engines at the shale mine bank was used to drive a 4 to 5 h.p. dynamo in addition to its regular work. The electricity thus generated was carried by a bare copper cable carried upon insulators on poles to an old quarry about one and a quarter miles distant. The wire is No. 10 B.W.G., the current about 10 to 12 amperes, and the tension at the dynamo terminals some 300 volts. At the quarry a motor is geared to a double-acting pump, with a 2 in. bore and a 2 ft. stroke. The water is raised through about 600 yards of 2 in. pipes, with a vertical rise of 135 ft., and is stored in a reservoir. The pump at 40 revolutions per minute deliver about 33 gallons. The pump-house is visited about once a day, for lubricating and inspecting the machinery; no further attendance is required. The condition of the pumps and their rate of delivery can be told by simply inspecting the ammeter and voltmeter in the engine-room. The resistance of the cable, 4,000 yards of No. 10 B.W.G., is about 7 ohms; and the loss in it averages about 1 h.p. The main engine is not appreciably affected by the small load, and the cost of maintenance is practically nothing beyond the wear of the plant. By no other means could the same work be done so cheaply and easily. The plant has now been running for about nine months. Mr. Hamilton, the manager of the shale mine, is thoroughly satisfied with the work done; and reports a considerable saving over the estimated cost of the various alternative schemes proposed at the time of ordering the electric plant. These plants have been selected from amongst the most recent installations carried out by Messrs. Immisch and Co. They are typical of work obtaining in mining, and show the means adopted to suit electrical plant to the every-day requirements of the coal pit. But the total work done in Great Britain by electricity is comparatively small, and one has to go to the continent or America to find the advantages of electrical plant fully appreciated. It will not be possible for me to refer at length to any foreign installations, but a brief resumé of some of the more important plants will show how much we are behindhand in this matter. On the Continent we find electricity used for hauling, pumping, and winding in coal, iron, tin, and salt mines. At the new Stassfurt salt mine, a motor was erected in November, 1885, for winding in a temporary inclined shaft, and continued to give satisfactory results till March, 1887, when the work was completed.

TABLE B.

No. of Trams.	1	2	3	4	5	6
Weight of trams	29cwt.	58cwt.	87cwt.	116cwt.	145cwt.	174cwt.
Pull on rope to draw trams	4.5 "	9.0 "	13.5 "	18 "	22.5 "	27 "
Pull on rope to overcome friction.....	98lb	196lb.	294lb.	392lb.	490lb.	588lb.
Current to run rope with trams	20.5 amperes.	26 amperes.	31.5 amperes.	37 amperes.	42.5 amperes	48 amperes.
E.M.F. at motor	390 volts.	430 volts.	450 volts.	465 volts.	465 volts.	460 volts.
Speed of trams in miles per hour.....	3.72	3.44	3.3	3	2.87	2.7
H.P. required to run trams at this speed	4.95	9.13	13.03	15.98	19.03	22.29
E.H.P. supplied to motor	10.72	15	19	23.01	26.5	29.6
H.P. lost in motor	.75	1.26	1.76	2.44	3.22	4.17
H.P. lost in leads	.7	1.15	1.7	2.2	3.02	3.86
No. of revolutions of engine per minute	58	58	57	56	54	52
E.M.F. at dynamo.....	416	463	490	511	518	520
H.P. lost in dynamo	.84	1.4	1.98	2.75	3.63	4.69
E.H.P. given out by dynamo ..	11.42	16.14	20.69	25.21	29.51	33.46
H.P. given out by motor	9.97	13.74	17.24	20.57	23.28	25.43
Ratio between h.p. given out by motor and e.h.p. given out by dynamo.....	87.5 per cent.	85.5 per cent.	83.5 per cent.	82 per cent.	79 per cent.	76.5 per cent.
Ratio between h.p. in rope and e.h.p. in dynamo.....	43.2 per cent.	56.6 per cent.	63 per cent.	63.5 per cent.	64.5 per cent.	67 per cent.

TABLE C.

Work done.	Speed of Engine.	Volts on dynamo.	Average amps. given out by dynamo.	E.H.P. given out by dynamo.	Work done in cylinder of engine.	Efficiency, per cent.	Loss in cables res. 29 ohms 800 yards. 19/16
Pumps delivering 39 gallons per minute	86	{ 171 ... 173.5 ...	{ 47.5 ... 47.5 ...	{ 10.9 ... 11 ...	{ 14.2 h.p. ... 14.2 h.p. ...	{ 6.3 ... 14.2 = 44.4	{ .88 h.p. ... 30.5 h.p. ...
Pumps running with the suction clack lids off and the column empty.....	86	{ 134 ... 128 ... 127 ...	{ 28 ... 28 ... 26 ...	{ 5 ... 4.82 ... 4.45 ...	{ 6.3 h.p. ... 6.3 h.p. ... 4.45 ...	{ }	{ 30.5 h.p. ... 305 h.p. ... 265 h.p. ...
Motor and first motion shaft only	{ 88 ... 86 ...	{ 111 ... 105 ...	{ 20 ... 20 ...	{ 2.96 ... 2.8 ...	{ 4.8 h.p. ... 4.8 h.p. ...	{ }	{ 156 h.p. ... 156 h.p. ...
Dynamo only, running on open circuit	86	0	0	0	1.715 h.p.	—	0

TABLE D.

Work done.	Gradient.	Volts.	Amperes.	Speed of motor.	E.H.P. put in motor.	Time taken for tubs to travel 100 feet in centre of track.	Speed of tubs during this time in miles per hour.	Traction as measured by dynamometer.
Seven loaded tubs	Up	280	31.5	1,500	11.8	Seconds	Miles.	
" "	Up	280	31.5	1,300	11.8			
" "	Up	301	{ 28 } { 32 }	1,520	{ 11.4 } { 12.9 }	21	3.25	Average 442lb. at first portion of up grade.
" "	Up	280	28	1,360	10.5			
" "	Up	280	27	1,380	10.2			
" "	Up	280	30	Not taken	11.3	23	3	Average 504lb. in centre of up grade.
" "	Up readings taken at different parts of the line	{ 287 287 294 294 }	{ 35 33 30 26 }	{ 1,100 1,200 1,300 1,500 }	{ 13.5 12.7 11.8 10.3 }	{ Start 21 Finish }	3.25	Average 704lb. at the end of up grade.
" "	Down	294	23	1,760	9.1		4	
" "	Down	291	25	1,740	9.8			
" "	Down	308	24	Not taken	9.9	17	4	
" "	Down readings taken at different parts of the line	{ 280 308 280 }	{ 28 21.5 23 }	{ 1,150 Not taken 1,780 }	{ 10.6 8.9 8.65 }	{ Start 17 Finish }	4	Average throughout the downward grade, 312lb.
" "	Down readings taken at different parts of the line	{ 280 287 301 308 }	{ 27 26 23 23 }	{ 1,300 1,400 1,600 1,750 }	{ 10.2 10 9.4 9.6 }	{ Start 17 Finish }	4	
Rope running without tubs	Down	217	15.75	1,720	4.5			
" "	Up	213.5	15	1,720	4.3			
" "	Up	213.5	17	1,620	5.25			
" "	Up	150	14.5	1,300	2.93			
" "	Up	145	13.5	1,250	2.63			
" "	Up	137	13.5	1,140	2.48			
Motor running with worm out	—	90 to 93.	{ 6 }	1,350	{ 0.725 to 0.75 }			

Since then a tail-rope haulage has been applied. Electric locomotives, driven by current supplied direct from a dynamo, have also been in use for some years at Zankerode, New Staassfurt, and Salzberg. It is needless to specify details, or multiply examples. In Switzerland, the application of electricity to transmission of power has recently received considerable attention, and some of the plants now being erected are of such magnitude as to throw

into the shade all the English and German, and most of the American installations. *American Installations.*—American electric installations are of the most varied character. The peculiar genius of the people adapts itself readily to novelties, and the rapid growth of wealth has contributed to the advance of the electrical industry. In all classes of work the dynamo and motor hold the foremost place, and thousands of machines are being installed

yearly. Indeed, so great is the demand for power plants that the numerous well-equipped factories are unable to keep pace with the demand; and, although millions of dollars are already invested in these concerns, the capital is likely to be doubled in the course of a few years. We cannot now consider the application of motors to tramways, railroads, hoists, fans, and the numerous requirements of factories and domestic houses, but must refer only to a few mining installations, and of these only to the largest. The most important up to date is one erected on the celebrated Comstock lode, at Virginia City, Nevada. The plant was required to work a battery of 60 stamps, with the complement of pans, settlers, agitators, rock-breakers, etc. The water power on the surface was totally inadequate, and steam power was out of the question owing to the cost of coal. Electrical engineers, however, met the difficulty. At the 1,650ft. level of the Chollar Mine, a chamber was excavated out of the solid porphyry, 50ft. in length, 25ft. in width, and 12ft. in height, clear of all timber. In this three Pelton water-wheels, each driving two dynamos, were erected. The surface water was collected in reservoirs and led down the shaft by two pipes, one 10in. and the other 8in. in diameter. At the bottom a Y unites these two pipes into a single one 14in. in diameter, out of which 6in. pipes lead to the nozzles of the water-wheels. The dynamos run at 900 revolutions per minute, are compound wound, and each give 130 e.h.p., so that the total output is about 800 h.p. The E.M.F. of each machine is about 3,000 volts. A separate pair of cables, more than a mile in length, is led from each dynamo to a suitable switchboard in the motor-room, so that any motor can be coupled to any dynamo. The motors all run at 850 revolutions per minute, and are coupled by belts to a common shaft, in the same way as we are running at St. John's Colliery. About 70 per cent. of the water power applied to the shafts of the dynamos is delivered for work at the main shaft in the mill. A truly splendid result. The water on leaving the Pelton wheels is to be used at a lower level to drive similar plant for use below ground. This magnificent illustration of the possibilities of electrical transmission has been running about 12 months without hitch or difficulty of any kind. It reflects the highest credit on the engineers, and should settle once for all the absurd objections raised by the ignorant to properly designed high-speed and high-pressure electric plant. The electric contractors are now putting down, for the Calumet and Hecla Mining Company, five 130-h.p. dynamos and five 80-h.p. motors. In this installation the power-station will be above ground, and the motors will be used for pumping below. I will only refer to one more American plant, and this, again, is so large as to sink into insignificance any in this country. At Big Bend Tunnel Camp, Butte County, California, the River Feather is diverted by an artificial dam, and led for two and a half miles by a tunnel through a mountain, and for two miles through the open country. At this point a fall of 300ft. is arranged to drive Pelton wheels coupled to dynamos. The current is carried for 18 miles by cables on posts. It feeds about 20 motors of from 5 to 50 h.p., all running in parallel off the mains. The E.M.F. at the dynamos is about 1,000 volts, at the motors it varies from 700 volts. The power is utilised for various purposes in the different mines. (Appendix I.). The test of the first Normanton pumping plant was made by Mr. E. Brown and myself, November, 1887. Pumps delivering 39 gallons per minute through a head of 530ft. = 6.3 h.p. in the water. (See table C).

The engine was of the girder type, with a single cylinder 14in. bore by 15in. stroke. The steam pressure was varied by a reducing valve according to the work required. During the test it was found that the slide valve nuts had shifted on the bottom end. The diagrams are thus defective, since the steam was admitted too late, and cut off too soon on the bottom end. This must have lowered the efficiency of the engine to some extent, and, of course, is against the net efficiency of the system. The power required to overcome the friction of the engine and dynamo without any load was 1.715 h.p. The motor ran at a speed of about 650 revolutions per minute during the test, the pumps making eight revolutions. The gearing consisted of three transmissions. The first a 10in. cotton belt, the second a morticed pinion gearing into a cast-iron wheel, and the third a cast-iron pinion and wheel on the crankshaft of the pumps. This complex system for reducing the speed of the motor was, of course, not originally designed so, but circumstances made it convenient to use gearing in this manner. The pumps were the differential four-throw rams afterwards used for the larger plant. They have been described in the body of the paper. (Appendix II.). The following test is interesting for two reasons. Firstly, it shows how inefficient high-speed worm gear is; and, secondly, it was perhaps the first published account of an electrical hauling plant. The line was laid on the hauling plane at the Newcastle Mining Exhibition of 1887. The test was made by Mr. M. Walton Brown, representing the Haulage Committee, assisted by Prof. Garnett and Mr. W. B. Sisling, Messrs. Immisch and Co. being represented by myself. The motor was reversed by the employment of two sets of brushes on a rocking frame, and was started with a number of iron resistance-coils in circuit, which were rapidly switched as the speed increased. With this arrangement the tubs were under perfect control, and a very sudden stop could be effected by reversing the motor with the resistances in circuit. The line was 100 yards long, 2ft. gauge, and was laid with 28lb. rails, the sleepers being at intervals of 3ft., just as in an underground road. The rope was 1½in. in circumference, and was carried round 5ft. sheaves at either end of the line. The sheave at the lower end had keyed to its shaft a worm wheel, which geared into a worm coupled to the motor shaft by a flexible coupling. The gearing ran in an oil bath. The worm was single threaded, and the wheel had 75 teeth; thus the motor made 75 revolutions for one of the driving sheave, and 75 revolutions of the motor corresponded to a movement of the rope of about 15.75ft. The worm was cut from cast steel, and the wheel was cast in iron. This gearing, however, was by no means satisfactory, the friction was considerable, and caused serious heating of the worm and wheel. The worm pitted

a little, though it stood the running fairly well, but the wheel wore away rapidly. The efficiency of such gearing is not more than 40 per cent., as will be seen from the figures given in the accompanying tabulated results. The tubs were seven in number, and were filled with scrap iron and loose ballast, making a total rolling load of 5 tons 6cwt. 1qr. 7lb. The motor was designed to run at 1,000 revolutions per minute, and to give out 15 brake h.p., the electrical quantities being 300 volts and 50 amperes. Since the motor was too powerful for the work, however, the speed and current varied, as shown in the table of observations made during the test. The tractive force required to move the loaded tubs and the rope varied between 312lb. and 704lb. This heavy traction is to be explained by the surface of the rails being in a very bad condition. The tension in the rope was also considerable, but was necessary to prevent surging, since the rope only made a little more than half a turn round the driving sheave. The road had a variable gradient, but rose roughly 1 in 75 on an average, though at places, judging by the tractive force rising to 700lb., the gradient must have been a good deal heavier. Table D will show in a convenient manner the results attained. The average work done on the rope on the up grade was

$$\text{1st part } \frac{412 \times 285}{33,000} = 3.3 \text{ h.p.}$$

$$\text{2nd part } \frac{504 \times 285}{33,000} = 4.3 \text{ h.p.}$$

$$\text{3rd part } \frac{704 \times 285}{33,000} = 5.75 \text{ h.p.}$$

Average work done on the rope on the down grade was

$$\frac{312 \times 352}{33,000} = 3.34 \text{ h.p.}$$

The weak point about the gearing undoubtedly lay in the very small pitch of the worm wheel and screw. The screw had only a single thread, and as the worm wheel was 30in. in diameter, with 75 teeth upon it, this corresponded to a pitch of only 1½in. The driving sheave was 60in. in diameter; and, therefore, when the traction on the rope, as measured by the dynamometer, was 504lb., the pressure between the screw thread and the worm must have exceeded 1,008lb. on account of the obliquity of the thread. Taking the effective diameter of the screw as 4in., and making 1,370 revolutions per minute, the relative velocity of the rubbing surfaces was 1,435ft. per minute. If we take the electrical horse-power taken up by the motor as 12, when the tubs were running up hill and the traction amounted to 504lb., and if we suppose the efficiency of the motor to be 90 per cent., which is probably rather above the mark, as it was running with less than its full load and at 37 per cent. above its normal speed, we have for the brake horse-power 10.8. The actual horse-power developed on the rope amounted to 4.36, leaving 6.44 h.p. absorbed in the friction of the gearing. This would correspond to a coefficient of friction between the screw and wormwheel of nearly

$$\frac{6.44 \times 33,300}{1,088 \times 1,435} \text{ or } 0.146.$$

Taking the run down hill in the same way, the coefficient of friction appears to be .151, but as the speed of the motor was much greater, and the whole power developed less, there must have been a greater percentage absorbed in the motor, so that the results are sufficiently consistent. As the cast-iron worm wheel wore very rapidly, and the oil became very gritty, it is probable that the coefficient of friction was not much less than 0.14.

LONDON COUNTY COUNCIL.

The first meeting of the London County Council after the summer recess was held on Tuesday, October 1, at the Guildhall, Lord Rosebery presiding.

The Highways Committee (Mr. A. H. Haggis, chairman) reported that they had considered the following notices, given to the Council, of works under Electric Lighting Orders, together with reports by the engineer and the solicitor thereon:

(a) August 27, 1889, from the House-to-House Electric Light Supply Company, Limited, of intention to lay mains for the supply of electricity in the parish of Kensington, as shown on plan sent with letter.

(b) September 2 and 6, respectively, from the Kensington and Knightsbridge Electric Lighting Company, of intention to lay mains in certain thoroughfares in Knightsbridge and Kensington.

(c) September 4, 1889, from the London Electric Supply Corporation, of intention to lay a distributing main under the footway on the south side of the Strand from the eastern boundary of the parish of St. Martin-in-the-Fields to the north-east corner of Northumberland-avenue.

(d) September 4, 1889, from the same company, of intention to lay distributing mains under the footways on each side of Victoria-street, Westminster.

(e) September 5, 1889, from the Metropolitan Electric Supply Company, Limited, of intention to lay mains and distributing-boxes in certain thoroughfares marked on five plans sent with the notice.

(f) September 9, 1889, from the Chelsea Electricity Supply Company, Limited, of intention to commence works for distribution of electricity in a portion of the parish of Kensington, shown in red colour upon the map sent with the letter, and forwarding a description of the proposed works.

In respect of the foregoing, the committee reported that with regard to (a), the committee, as the notice expired on the 30th ult., had assented on behalf of the Council to the proposed works, subject to

the condition that the covers of the surface-boxes shall consist of iron frames filled in with stone or other suitable material, and shall be in all respects subject to the approval of the engineer of the Council, and that the mains shall be laid under the footways, except when the engineer of the Council shall consider it impracticable so to do. The Council now ratified the course taken. With regard to the other notices, the committee recommended as follows:

(b) That notice be given to the Kensington and Knightsbridge Electric Lighting Company of the Council's disapproval of the works referred to in the company's notices dated 2nd and 6th September, 1889, respectively.

(c and d) That the Council do approve such works, subject to the conditions that the mains crossing the carriageway of side streets be laid under the concrete.

(e) That the Council do approve of so much of the works referred to in the notice as are shown upon the plans marked No. 1, No. 2, and No. 3, and signed by the chairman of the committee, upon condition that the mains shall be laid, wherever practicable, under the footways, and that the covers of the testing-boxes shall consist of iron frames filled in with stone or other material to suit the pavement.

(f) That the Council do approve of the works specified in the notice of the Chelsea Electric Supply Company, subject to the condition that the covers of the distributing and other boxes shall consist of iron frames filled in with stone or other material to suit the paving, and that the mains shall be laid, wherever practicable, under the footways.

The objection to the Kensington and Knightsbridge Company was understood to be on account of the largeness of the distributing-boxes which the company proposed to adopt.

At the meeting of the Council held at the Guildhall, on Tuesday, October 8, the Highways Committee reported that they had considered the following notices given to the Council, of works under Electric Lighting Orders, together with reports by the engineer thereon:

(a) Three, each dated September 20, 1889, from the London Electric Supply Corporation, of its intention to lay distributing mains under the footways (1) in Trafalgar-square, Spring-gardens, Haymarket, Cockspur-street, Coventry-street (part of), Pall Mall East, Carlton House-terrace; (2) Pall-mall, Piccadilly (part of), St. James's-street (part of), Charles-street, St. James's-square, King-street (part of), York-street, Regent-street (part of), Haymarket, Duke-street (part of); (3) St. James's-street (part of), Piccadilly (part of), as shown upon a plan accompanying the notices.

(b) October 3, 1889, from the Kensington and Knightsbridge Electric Lighting Corporation of its intention to lay mains, and straining-up and service-boxes in certain thoroughfares in Knightsbridge and Kensington.

The committee recommended the Council to approve of these works, and the recommendation was adopted.

CITY NOTES.

Direct Spanish Company.—The traffic receipts of this Company were £2,139, against £1,888.

West Coast of America Telegraph Company.—The receipts for the month of September amounted to £7,250.

Electricity Supply Company for Spain, Limited.—The list of applications for shares in this Company closed yesterday.

Eastern Telegraph Company.—The traffic receipts for September were £51,881, as against £49,273 for the same period of 1888, or an increase of £2,608.

Great Northern Telegraph Company.—The traffic receipts of this Company for September were £25,000, making, from January 1, a total of £203,200.

Eastern Extension Telegraph Company.—The traffic receipts for the month of September were £40,418, as against £41,095 for the same period of 1888.

Globe Telegraph and Trust Company, Limited.—The Board of this Company have declared an interim dividend of 2s. per share, payable on the 18th inst.

Cuba Submarine Telegraph Company.—The traffic receipts for September were £2,400, as compared with £2,774. The receipts for June, estimated at £3,300, realised £3,397.

Western and Brazilian Telegraph Company, Limited.—The receipts for the week ended October 4, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £1,604.

Brazilian Submarine Telegraph Company, Limited.—This Company recommend a final dividend of 1s. per share, making, with previous distributions, a total dividend of 6 per cent. for the year ended June 30, and also the payment of a bonus of 3s. per share, both tax free, being a distribution of $7\frac{1}{2}$ per cent., and leaving £47,609, of which amount £4,500 has been placed to the reserve fund, increasing it to £259,660, £2,609 being carried forward. The above dividend and bonus will be payable on November 7. The receipts of the Company for the week ended October 4 amounted to £2,936.

NEW COMPANIES REGISTERED.

Electricity Supply Company for Spain.—With a capital of £100,000 in 19,900 ordinary shares of £5 each, and 100 founders' shares, this Company has been formed primarily for the purpose of erecting a central electricity supply station in Madrid, under a concession recently obtained from the authorities there, for the purpose of generating electricity on a larger scale, and distributing it by means

of underground mains to premises requiring electric lighting or motive power. Messrs. Hammond and Co., whose engineers erected the Kensington central station, have contracted to erect a similar central station in Madrid, with plant for 25,000 8-c.p. lamps, and to provide the necessary land for the sum of £80,000, which covers their remuneration for obtaining the grant to the Company of the concession. The ordinary shares are now offered for subscription. The profits of each year are applicable first to the payment of a dividend at the rate of 7 per cent. on the ordinary shares, and, subject to the provisions of the articles of association, one-half of the surplus profits belongs to the holders of the ordinary shares, and the other half to the holders of the founders' shares.

Electrical Accessories Company, Limited.—Registered by W. T. Cooper, 29, Essex-street, Strand, W.C., with a capital of £5,000 in £1 shares. Object: to carry on the business of electricians, gas and general lighting engineers, etc. The regulations of table A, with slight modifications, apply.

PROVISIONAL PATENTS, 1889.

OCTOBER 1.

15377. **Improvements in electric machines or motors.** Charles Carroll Peck, 55 and 56, Chancery-lane, London. (Complete specification.)

15402. **Improvements in or relating to alternate current electric distribution.** William Phillips Thompson, 6, Lord-street, Liverpool. (George Westinghouse, jun., United States.)

15446. **Improvements in the method of and apparatus for "forming" or charging plates for electrical accumulators.** Stanley Charles Cuthbert Currie, 24, Southampton-buildings, London. (Complete specification.)

15449. **Improvements in electrical cables.** Walter Twiss Glover, 47, Lincoln's-inn-fields, London.

OCTOBER 2.

15489. **Improvements in electricity meters.** Francis Teague, 433, Strand, London. (Complete specification.)

OCTOBER 3.

15509. **Improvements in electric bells.** Charles Henry Martin, 11, Corporation-road, Middlesbrough.

15524. **Improvements in electric bells.** Frederick Herbert Berry, 186, Fleet-street, London.

OCTOBER 4.

15567. **Improvements in means for propelling vehicles by electricity.** Joseph Kincaid, Edward Manville, and John Edward Waller, 47, Lincoln's-inn-fields, London.

15609. **Improved electrical railway switch and signal apparatus.** Franz Zaver Bachmann, 22, Southampton-buildings, Middlesex.

OCTOBER 5.

15643. **Improvements in rheostats or apparatus for regulating electric currents.** John Augustine Kingdon, 29, Marlborough-hill, London.

SPECIFICATIONS PUBLISHED.

1887.

9515. **Tanning by electricity.** Worms and Balé. (Second edition.) 8d.

1888.

11354. **Utilising electric energy, &c.** Lorrain. 8d.

11898. **Indicating strength of current upon an electric circuit.** Shallenberger. 8d.

15550. **Telephonic communication.** Sack. 8d.

15601. **Electric bells.** Harecourt. 6d.

15713. **Connector for electrical conducting wires.** Solomons and Faraday. 8d.

16905. **Electrical locks.** Dymond (Schwenke.) 8d.

1889.

11900. **Conduit for electric railways.** Dallos. 6d.

12731. **Secondary batteries.** Kookogey. 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name	Paid.	Price Wednesday
12 Feb.	1/2	Anglo-American Brush E.L.	—	4½
12 Feb.	2/0	— fully paid ..	—	5½
14 Nov.	0/4½	Con Telephone & Main ...	1	3½
27 July	10/0	India Rubber, G. P. & Tel.	10	19½
.....	...	House-to-House	4½	5
.....	...	Metropn Electric Supply	—	3½
.....	...	London Electric Supply ...	5	4½
.....	...	Swan United	3½	5½
12 July	12/0	Telegraph Construction ...	12	43½
2 July	6/0	— 6%, 1889	100	105
... ..	...	National Telephone	5	6½

NOTES.

Berlin.—An installation of the electric light has been inaugurated at the Alliance Theatre, Berlin.

Tramways in Italy.—The first electric tramway in Italy is soon to be opened between Florence and Fiesole. Its total length will be about $4\frac{1}{2}$ miles.

Derby.—A meeting of the Derby Town Council is fixed for November 9th, when a resolution will be moved to apply for a provisional order on behalf of the Corporation.

Station Lighting at Bombay.—A movement is now on foot by the authorities of the Great Indian Peninsula Railway Company at Bombay to light the Victoria Terminus with electricity.

Paris Medal.—A silver medal has been awarded to Mr. Samuel Elliott, Albert Steam Joinery Works, Newbury, for his patent weather bar, wood mouldings, and electric light casings.

Rysselberghe System in China.—The first installation has just been finished in the North of China of a combined telegraphic and telephonic system on the same wire, on the system of M. Van Rysselberghe.

Rochdale.—The Town Council of Rochdale has considered the question of electric lighting, and have come to the conclusion that they do not consider it desirable at present to apply for a provisional order.

Southwark Subway.—The offices of the City of London and Southwark Subway Company are removed to the company's City station, 46, King William-street, E.C., the entrance being in Arthur-street East.

Portsmouth.—The Laing, Wharton, and Down Construction Syndicate state that they have lodged an application with the Board of Trade for a provisional order to enable them to instal the electric light in Portsmouth.

Keighley.—A special meeting has been called for November 9 to approve of an application to the Board of Trade by the Keighley Town Council for a provisional order authorising the supply of electricity within the borough.

Budapest.—It is announced that the Society for the Installation of Compressed Air and Electricity has addressed to the Municipality of Budapest a request for a concession for an installation of one or more central stations of electric light, with underground cables.

Windsor.—At the next meeting a motion will be presented to the Urban Sanitary Authority that the Council apply for a provisional order, appoint a committee to consult an electrical engineer, and invite tenders from companies of experience with a view of utilising the large steam and water power the Corporation now possess at the water works.

Discussion on Electrical Transmission.—The next general meeting of the Chesterfield and Midland Counties Institution of Engineers will be held at University College, Nottingham, on October 12, at 3 p.m. Mr. T. M. Winstanley Wallis's paper, "Electric Lighting, and the Transmission of Power by Electricity," will be open for discussion.

Lighting the Underground.—It is well known that the Deptford scheme is to bring its mains along the southern railway lines to Charing Cross and Cannon-street. Arrange-

ments have been made to take their mains round the inner circle railway, and a complete scheme for lighting this great thoroughfare of London travel has been prepared and is under consideration.

Bournemouth.—The Town Council of Bournemouth read a letter from the Brush Company last meeting, in which it was said that this company were about to apply for a provisional order for supplying electricity in the town. The area would include the whole of Bournemouth, and it was suggested that the Lighting Committee should meet the promoters for an interview.

Electrified Wine.—It seems that experiments are now being made in Italy upon this year's vintage, in the electrification of wine. Fifty different sorts of wines have already been experimented upon, and the results have been very satisfactory. The wine is clarified, acquires a "bouquet," and, it appears, stands equally well transport by land or long journeys by sea.

Cheltenham.—An exhibition is being held at the Winter Gardens, Cheltenham, and the Mayor and Corporation last week paid a visit to the exhibition for the purpose of inspecting the temporary installation of the Thomson-Houston system. Four arc lamps were placed along the approach, and the stage was illuminated with incandescent lamps. The visit afforded much satisfaction to the members.

Electric Execution.—A New York telegram of Oct. 11, says: The execution by electricity of the man William Kemmler has not yet been definitely decided upon. The county judge at Auburn, New York State, on Wednesday decided that the law regarding execution by electricity was constitutional, but the counsel of the condemned man will nevertheless appeal to a higher court for a decision in the matter.

Safety Railway Signalling.—According to the *Railway World*, an ingenious signalling device is about to be used on an American railroad. A shunt circuit is formed, so connecting the semaphore signal and the operator's key that when the safety signal is displayed the key cannot be used. The result is that the signalman must keep his signal at the normal danger point when a call distracts his attention.

New York Streets in Darkness.—A New York telegram of October 15 says: Last night the principal streets of New York were in darkness in consequence of the electric light companies having stopped the currents. The action of the companies is due to a dispute existing between them and the authorities on account of the dangerous condition of overhead wires, shocks from which have recently caused some deaths.

Archbishop of Dublin's Palace.—A splendid palace is now being erected at Drumcondra, a Dublin suburb, for Dr. Walsh, the Roman Catholic Archbishop of Dublin. The palace will afford a vast amount of accommodation, and will contain a special hall for the conferences of the Roman Catholic bishops of Ireland and the Archbishop's receptions. The oratory will be exceptionally beautiful, and the whole building will be illuminated by the electric light.

Hungarian Telegraphy.—The reduction of telegraph charges in Hungary to a penny for ten words looks as if the Hungarians find the post or the carrier's cart quite quick enough for the transmission of their ideas. The full force of this concession, says the *Financial News*, cannot be

understood until the length of some of the words in the language is remembered. As one word can be made to carry a sentence, ten words should be able to carry a leading article.

Deptford.—Owing to the unfortunate strike at Silver-town the opening of the Deptford station has been delayed. The company are anxiously waiting for the delivery of some small but necessary goods to complete the dynamo, and are unable to run until they receive them. With this exception, everything else is ready, and current has already been sent along the wires from the Grosvenor station to Deptford, and the works there have been illuminated by means of the same.

Contract.—Tenders are invited by the South Hornsey Local Board for the construction and maintenance, for a period of seven years, of electric street fire alarms, to be connected with the fire station in Milton-road, South Hornsey. The specification of the proposed work can be seen, and particulars obtained, on application to the Acting Surveyor, at the Board Offices, Milton-road, South Hornsey, any morning between nine and eleven o'clock. Tenders to be sent in to Mr. Edward R. Bennett, clerk, on or before November 12, 1889.

Telegraph Money Orders.—We have no official notification of the success or otherwise of the system of telegraphing money orders as yet, but it would seem that the expenses involved do not encourage its use in any but cases of absolute necessity. The commission and expense, now amounting to thirteen pence for a pound, is equal to some 17 per cent. for transmission, and though for larger sums the percentage is less, it is thought that the charges must be modified before the scheme can be considered commercially practical.

Telephones at Worcester.—The telephone does not seem to flourish at Worcester. Although the company have offered to give free connections to the police-station, fire-station, and the infirmary, if a reasonable number of subscribers take it up, yet they do not appear to be successful, and it is hinted that the company are so disgusted with the way they have been met during the past two years—they have been trying hard, and have lost many hundreds of pounds in the attempt—that they are determined to close all up and leave the city at the end of the present month unless they are at once well supported.

Electric Submarine Boat.—The French Government have recently undertaken trials with a new electric submarine boat, the "Goubet." It is quite a small boat, 18ft. long and 5ft. wide, and accommodates two persons. The hull is a bronze casting capable of sustaining great pressure, and the boat, fully equipped, weighs five tons. Power is obtained from an electric motor driven by accumulators, which can be charged either from the shore or a ship. The boat has been submerged at a depth of 33ft. for eight hours, with a crew of two sailors, the atmosphere being maintained in a normal condition from a supply of compressed air.

Tynemouth Applies for an Order.—A special meeting of the Tynemouth Town Council was held last week at the Town Hall, North Shields, for the purpose of considering the desirability of applying for a provisional order to supply electricity within the borough. The Mayor (Mr. R. Collins), who presided, moved that the Council apply to the Board of Trade for an order. Councillor Spencer seconded. Councillor Jewells moved, as an amend-

ment, that the question be laid on the table for twelve months. This was seconded by Councillor Marshall, but after considerable discussion the motion was carried by twelve votes to four.

Arts and Crafts.—Several dainty and artistic pendants and electroliers are exhibited, hanging in appropriate positions, in the Arts and Crafts Exhibition, at the New Gallery, Regent-street. The Globe Electrical Engineering Company exhibit some wrought and twisted iron electroliers of the kind we recently illustrated. These were designed by W. Herbert Singer, and executed by J. W. Singer and Sons; craftsmen, A. Trowbridge and A. Halliday—these latter, the workmen, having been awarded a prize by the Society of Arts for their work. Messrs. Jas. Powell and Sons show a wall bracket for electric light, and a 3-light electrolier in wrought iron and glass; Reginald T. Blomfield has a fine standard for gas and electric light (executed by Robert White); Richard L. B. Rathbone has a pendant for three electric and three gas lamps, the glass designed by W. A. S. Benson, and made by James Powell and Sons.

Pocket Information.—The General Electric Company have sent us some cards for use by electrical engineers, which they are distributing, and intend to continue to issue weekly. The first three consist of (1) Mr. W. H. Preece's "fuse tables," issued with his permission, giving fusing current of various thicknesses of wire, tin, lead, copper, or iron that will be fused at a certain current; (2) list of casings with sizes of wire or cable they will contain, and current these will carry, with also exterior sizes of the casing and prices per 100 or 1,000ft. run; (3) list of carbons from 8 to 30 millimetres with a millimetre scale attached. These cards are certainly an ingenious idea for supplying information on various matters, on a small scale, as that they can be easily carried in the pocket or slipped in a pocket-book, and we have little doubt that most persons in the trade will be glad to avail themselves of the intention of the company to send them to whoever will notify them of their wish.

Mansion Lighting.—The mansion of Scatwell, situated on the banks of the River Conon, about 10 miles from the Muir of Ord railway station, and belonging to Mr. W. J. Bell, has just been fitted up on the most complete scale with the electric light. Acting on the advice of some of his scientific friends, Mr. Bell recently engaged the services of Mr. R. F. Yorke, electrical engineer, who has had special experience in carrying out electric lighting by means of water power, and who has carried out the work at Scatwell with great success. The electricity is supplied by means of a turbine wheel and dynamo situated about 200 yards from the house, and connected with it by cables laid underground. A set of accumulators in the basement assures light during the longest winter night, the turbines only needing to be run for about seven hours a day. The working expenses are found extremely small. Mr. York also introduced the same system at Ancrum, the seat of Sir W. Scott, Bart., and at Ardwell, the residence of Mr. Mark Stewart, M.P.

Electric Railway Signals.—Messrs. Dutton and Co., who recently took the West Central Waggon Works, Worcester, and commenced business therein as railway signal engineers, have turned their business into a private joint stock company, says the *Railway Engineer*, with a capital of £60,000. The company will also acquire the

whole of the patents recently granted to Mr. S. T. Dutton in connection with mechanical signalling, and in addition has secured an exclusive license for the manufacture and sale of the whole of the Timmis and Currie-Timmis patents in connection with electrical signalling. The whole of the issued capital has been subscribed for by the partners and by gentlemen interested in railways. The works at Shrub-hill are to be extended, and will in future include the manufacture of the necessary electrical plant for carrying out the above object. The company has secured the services of Mr. Illius Timmis as consulting electrician. Mr. J. P. O'Donnell, late of the London and South-Western Railway, will act as London agent, at the offices of the company, Great George street, Westminster.

Tender for Lighting Bombay.—The municipal commissioner for the city of Bombay is inviting tenders for an experimental central installation for lighting the main road from the Crawford Markets to the Apollo Bunder. The length of time of the experiment will not be guaranteed at longer than two years. The mains will be required to be laid underground, and a free site will be allowed during the time of the experiment. The system proposed must be specified, the number and position of lamps, the illuminating power, and the rates to be charged monthly. An extension in three directions will also be optional. On application at the office of Messrs. E. W. and R. Oliver, solicitors, 1, Corbet-court, Gracechurch-street, London, E.C., a printed slip giving information as to the hours of lighting, and a map of the section of the city to which this notice refers, can be obtained on payment of £1. Duly authenticated testimonials from the municipal authorities of any town in which firms tendering in response to this notice may have already conducted operations will receive special consideration. The tenders should be sent to the Municipal Offices, Bombay, by January 9, 1890.

St. James.—At the St. James's Vestry on October 10, a report was read from the Lighting Committee, recommending that the London Electric Supply Corporation be informed, with reference to their notice of intention to lay mains in certain streets, that the Vestry have no desire to oppose the commencement of operations on technical grounds, but that before approving of any plan or giving consent to any such work, they feel it their duty to ascertain that the preliminary obligations of the provisional order have been complied with, and would therefore be glad of information as to whether the corporation have yet satisfied the Board of Trade that they are in a position fully and efficiently to discharge the duties and obligations imposed upon them by the order, whether they have yet deposited or secured the sum prescribed by the 7th section, and what steps they have taken in the matter of providing a second generating station. A letter was read from the Board of Trade, stating that they were still in communication with the company respecting their financial position. A letter was also read from the company, stating that they expected to be able to give the Board the necessary assurances in the course of a few days. Mr. W. Jenkins said under the circumstances disclosed by the two letters they had read, he would move that the whole matter be referred to the General Purposes Committee for consideration and report. This was seconded and carried.

He Slept on It.—Here is a story about a bishop, told by the *Pall Mall Gazette*, which should not be lost to the electrical profession. Our readers will notice one or two improbabilities, but the story is a good one: "Bishop was

homeward bound from the States, travelling luxuriously in a double cabin with Mrs. Bishop. It was a very hot night, thunder in the air, and as the Atlantic liner slipped through the water, doing her eighteen or nineteen knots an hour, the cabin would be lit up with the lightning flashes. Mrs. Bishop could not sleep for the heat. Bishop was appealed to, lumbered out of his berth and opened a porthole. Suddenly there bobbed in through the porthole a wooden ball attached to a string. Bishop was perplexed, but he tied it up, coiling the string by a nail in the wall, and then retired to rest. The ball was an apple of discord in that peaceful cabin, for it hit against the side of the vessel as she lurched, and Mrs. Bishop grew querulous and disturbed. Up started the poor bishop again, and to end matters, he uncoiled the cord, and put the ball safe and sound under his pillow. There was a heavy thunderstorm, but the bishop slept soundly that night. Next morning at breakfast, the captain presiding, he told the tale with a good deal of episcopal solemnity and detail. The captain laughed consumedly. Bishop laughed too, thinking his story a good one. Then the captain told him that the ball was the end of the lightning-conductor. Bishop that night looked under his pillow before going to bed, and slept with a closed porthole."

Barnet and the Heisler System.—For some time Messrs. Joel and Co. have been negotiating for the introduction of the celebrated Heisler series incandescent system into Barnet. The Heisler system is practically the only series incandescent lighting that has achieved a real success, and in America there are over 20,000 lights of 30 c.p. running in public streets and in private houses. These are mostly in sets of 50 to 300 running on a single wire. The apparatus has been exhibited for the first time in Europe at the Paris Exhibition, and the ingenious automatic regulation and the great brilliancy of the lamps has excited much comment. The patents have recently been made over to an important American gas corporation—The United Gas Improvement Company—who have been converted to the advocacy of electric lighting. The Heisler system has been run for some years in several towns in America, and has only just recently been audaciously planted at Orange, under Mr. Edison's very nose. It is evident that a company accustomed to put up public installations every week or so, will have no difficulty in adapting the system to Barnet. The present mains and posts will not be touched, the dynamo, automatic regulator, and lamps with their cut-outs only being proposed to be introduced. We shall be pleased to see what the effect of this move will be upon the critics of Barnet, and there is no doubt the whole electrical and gas profession will be greatly interested in the introduction of the Heisler system in England.

A Portable Telephone.—A useful practical application of the telephone to military, railway, and other purposes has been effected by Messrs. Mix and Genest, telegraph engineers, of Berlin. This apparatus, which has been recently on view in London, is contained in a case 12in. long by 6in. wide and 8in. deep, which, for general purposes, is slung by a strap in front of the user. This case contains a dry cell battery, a magneto bell, and an induction coil. In some instances, where it is desirable that the sound of the bell should not be heard, the Neef hammer is substituted for it, and is used as a means of calling attention between the communicating parties. The case also contains a combined receiving and

transmitting apparatus, which is fitted with Mix and Genest's microphone, as a transmitter, the apparatus being conveniently made for application to the ear and mouth. For field purposes an outpost equipped with the apparatus proceeds to the front, his telephone being in communication by a wire with that of the field watch, the latter being again in telephonic communication with headquarters to the rear. A number of outposts, either infantry or cavalry, may be on duty at the same time, and in communication with the field watch, who will transmit to headquarters the reports received from the outposts. At recent trials the apparatus worked clearly and well. It is also applicable to railway, mining, and other similar purposes. It is suggested that a portable telephone might be carried with every train, so that in the event of accident the guard should be able to communicate with the nearest station by making a connection with the conductor of his instrument and a wire carried along the line.

Bombay.—The *Times* of Bombay gives a long description of the beauties of the new palace of the Maharajah Gaekwar at Makuspura. The place is most richly decorated in the manner beloved of Oriental princes, and is furnished with the electric light. The palace will cost 50 lakhs of rupees. It has been furnished throughout with electric light by Messrs. Siemens Bros. The interior is lit with 215 16 c.p. incandescent lights, and they are used in a variety of glasses. One favourite form is the frosted bulb, which prevents the filament from being seen, and at the same time renders the light very pleasant to the eyes. The large hall is illuminated with two large 12-light electroliers made in bronze and lacquered work, while the light is softened and diffused by dioptric shades. Single lights are also pendant from the ends of the columns of the gallery. In some of the other rooms are three and four-light electroliers, made in a variety of pretty designs to suit the surroundings. In the two bedrooms on the first floor the mirrors have been specially fitted with brackets, which will permit of the mirrors being shifted from one room to another, and there is also a hand lamp, which can be moved about and placed at the back of the head when a lady is at her toilet. Each of these lights can be put out separately, and the others in the room left burning. On the ground floor is a board with seven large switches, and by turning these the whole of the palace is lit. On the top of the palace are 12 50-c.p. lamps, which cast a brilliant illumination over the flat roof and the surrounding grounds, which are also to be subsequently elaborately lit up. The necessary power for lighting is supplied by two engines and two dynamos, one set for each palace, but, if necessary, they can be used for either palace, or both used for one. The Gaekwar has thus provided himself with a brilliant residence, and provided in India an example which must needs lead to imitation immediately, and such a "spreading of the light" as can hardly be anticipated.

City Lighting.—The report of the Streets Committee of the Commission of Sewers which is to be discussed at the next meeting, contains the following observations: "On carefully considering the tenders sent in, together with the suggestions of the companies in regard to conditions, it was found that the tender of the Anglo-American Brush Company was the only one practically in accordance with the specification, and under the advice of Mr. Preece they instructed the officers to negotiate further with the Metropolitan Electric Supply Company and the London Electric Supply Company, with a view to arrange similar

terms with them. This had since been done, with the result that they had severally modified the terms of their tenders so as to bring them into conformity with that of the Anglo-American Brush Company, and, broadly, all these three companies now agreed to accept the terms of the original specification, modified only in terms of the provisional orders and sanctioned by the House of Commons. The prices per annum per glass lamp were as follows: The London Electric Supply Corporation, £24. 3s. 10d.; the Metropolitan Electric Supply Company, £26; the Anglo-American Brush Company, £26; but the London Electric Supply Corporation proposed to extinguish half the lamps at midnight. After full consideration the committee recommended that the tenders of the said three companies be provisionally accepted, subject to their agreeing to enter into a contract for 21 years, determinable by either party at the end of seven or 14 years, and the London Electric Supply Company waiving the condition as to extinguishing half the lamps at midnight; that the three districts into which the City is divided for this purpose be allotted as follows—viz., No. 1 (West), to the Metropolitan Electric Supply Company; 2 (Central), Anglo-American Brush Company; 3 (East), London Electric Supply Company. The committee say that to light the main thoroughfares by the means of 395 arc lamps the cost would be £10,024, in place of 1,730 gas lamps, costing £5,530 per annum; but while the price would not be double that of gas, the amount of light would be many times greater.

Ingenious Deep-Sea Fishing.—In the investigations that were undertaken by the Prince of Monaco in deep-sea soundings, extending from the banks of Newfoundland to the coast of Africa, a most ingenious method was adopted to bring specimens of the living creatures existing at great depths in the ocean. The apparatus as used is displayed at the Pavilion of the Principality of Monaco at the Paris Exhibition. The cage in which the submarine animals were caught, according to *Le Genie Civil*, consisted in a cylinder of wire having three conical entrances, like those of a lobster pot, and weighted for submersion with detachable weights. It was, however, very unlikely that at these immense depths, where the darkness is practically total, any fishes would voluntarily find their way into the trap, and steps were taken to attract them by a light placed inside it. Obviously, no light was available but an electric light, but to get an electric light to burn a mile or two under water was not easy. To send the current from above was impracticable, as the friction of the thick insulated wire would cause it to break before the trap could be drawn up, and the only resource was to supply the incandescent wire from a battery in the trap. Here, however, another difficulty appeared. The battery, which must be of considerable power, needed to be enclosed in a box of some kind to keep it from being affected by the salt water, and as the hydrostatic pressure at such depths was six or seven hundred pounds per square inch, it was found impossible to make a suitable box which was not crushed before it reached its destination. At last, however, this trouble was overcome by the curious device of connecting the box with a balloon. The balloon was made of cloth dipped in india-rubber, and so arranged that the air in it was in communication with that in the battery-box. On sinking the apparatus, the hydrostatic pressure, being virtually uniform all round the balloon, compressed it equally on all sides, forcing the air out of it into the battery-box, until the pressure inside the box and balloon exactly balanced the

pressure outside. This process went on to any extent, so that at the bottom of the sea, although the balloon was reduced by the enormous force exerted on it to a small fraction of its original size, it still kept the internal and external pressures equal. On raising the apparatus again it expanded as the pressure diminished, and brought the battery-box to the surface uninjured. So successful was this device, that, not content with capturing deep-sea fishes with it, the prince and his assistants propose on their next expedition to send down a photographic apparatus and bring back negatives of the bottom of the ocean, as seen by the electric light.

Long Distance Lighting.—One of the longest incandescent light circuits in existence has been erected the present season by the Illinois Valley Electric Light and Power Company, Ottawa, Illinois. The company had to meet the competition of a company already established, operating both arc and incandescent circuit in Ottawa, and controlling the water power rights along the Illinois river for a considerable distance. There was, however, an excellent water power at Marseilles, eight miles distant, and after canvassing the cost of a steam power plant it was finally decided to erect the works at Marseilles and adopt the Heisler long-distance incandescent system. Work was pushed as fast as possible, and in August the plant was placed in successful operation. At Marseilles a dam was erected, 930ft. between bulkheads, raising the Illinois river 7ft. to 14ft., and setting back the water a distance of 20 miles. The new American turbines were placed in the wheel-pit and connected to a Heisler dynamo of 700 30-c.p. lamps capacity. For the trunk line wire No. 8 B. and S. gauge was used, hard drawn and weatherproof. The total length of the circuit is about 45 miles. It is eight miles from the dynamo station to the first light in Ottawa. The light is as brilliant and steady at points of the circuit farthest from the dynamo as it is in the power station. In Ottawa the company has now 300 30-c.p., 150 20-c.p., and 100 15-c.p. lights, besides 20 lights ranging from 40 to 100 c.p. In Marseilles, the company is now running 15 30-c.p., 50 20-c.p., and 20 15-c.p. lights, and it is expected soon to supply the city with 15 street lights, and also to secure a contract for street lights in Ottawa. A circuit is also to be put in to supply Seneca, five miles east of Marseilles, with electric lights. The feature of great interest in this plant is the length of the circuit and the area which it covers. In the early days of electric installations great stress was laid on the facility with which water power located at remote and inaccessible points could be utilised to furnish light or power at the points desired, many miles away. With most of the systems in use, however, it has been found that the cost of the great amount of copper required for the large wires which were necessary in long circuits, prohibited the placing of the dynamo at any considerable distance from the point where the current was to be utilised. By the Heisler system, as is proved by the above installation, this difficulty is to a large extent overcome; and the utilisation of water power, distant several miles from the point where the electric current is desired, is now quite feasible. There can be little doubt that this will lead to the utilisation of many water powers which are too remote to be of any use for other purposes. It is not known that any longer incandescent circuit, or even any longer arc circuit, is now in operation; and the fact that this circuit is operated with so small a wire gives proof of the economy of the Heisler

system in cost of copper. Among other installations of the Heisler system now in progress, one of the most novel is for the Standard Light and Power Manufacturing Company, of Montpelier, Vt. A 300 30-c.p. plant is being erected there, and the lights are to be rented at a distance of four miles from the station. A plant of the same capacity is being put in at Ludington, Mich., where arc lights alone have been used heretofore. Plants are also being erected for the Globe Furniture Company, Northville, Mich., and in the Farmers' Market Building on North Broad-street, Philadelphia, Pa. A plant is nearly ready for shipment to London, which will be the first Heisler installation in England.—*New York Engineering News*.

Edinburgh Electrical Exhibition, 1890.—On October 10 a deputation of the Executive Council, consisting of Bailie Walcot, Councillor Pollard, Councillor Robertson, Mr. A. R. Bennett, Mr. C. H. Barclay, Mr. Geo. E. Watson (secretary), and Mr. Lee Bapty (general manager) waited on the Lord Provost, Magistrates, and Town Council of Glasgow with a view of interesting them and, through them, the people of Glasgow, in the forthcoming exhibition. The deputation was introduced by Bailie Dunlop (Glasgow). A letter of apology for unavoidable absence from Sir William Thomson was read. After hearing speeches explanatory of the objects and scope of the exhibition from Bailie Walcot and Mr. A. R. Bennett, the Lord Provost (Sir James King) said they had been much interested in what had been stated in regard to the proposed exhibition. In ordinary circumstances, however, if the exhibition had been merely of a general character, he had no doubt that the Council would have thought that it was rather too early to risk another general exhibition in Edinburgh, but they who were members of the deputation had put before them very clearly that the main object they had in view was to afford the people of this country an opportunity of knowing and ascertaining the progress that had been made in electrical science, and he was sure that they in Glasgow had a special interest in that exhibition from the fact that the question of electrical lighting must very soon be dealt with. The Town Council remitted the consideration of their former application to the magistrates, and he believed his colleagues and himself would be prepared after they left to make a recommendation to the Town Council on the matter. Suffice it to say that they wished them every success, and, remembering the substantial help which they received from Edinburgh at the time of their exhibition in Glasgow, he was sure they would gladly do what was in their power to add to the success of their undertaking. Councillor Robertson thanked the Lord Provost and the members of Council, after which the deputation withdrew. The Lord Provost next said that he might state that the magistrates had carefully considered the question of the electrical exhibition in Edinburgh, and regarded it as one that ought to be encouraged, and as one which was calculated to be practically useful to the whole of Scotland; and remembering the liberality with which the Town Council of Edinburgh gave subscriptions to their guarantee fund at the time when their exhibition was in progress, the magistrates were unanimous in recommending that the Town Council of Glasgow should subscribe to the guarantee fund of the exhibition for the sum of £500, the Town Council of Edinburgh having already subscribed for the sum of £1,000. He moved accordingly, and the Council agreed to the proposed guarantee unanimously.

JUNIOR ENGINEERING SOCIETY.

PRESIDENTIAL ADDRESS.*

This society expects from its president for the year an inaugural address, with whose subject matter he is supposed to have a special kind of acquaintance, and which is of importance to the society.

As a mechanical engineer whose apprenticeship began 25 years ago, and who has paid a considerable amount of attention to electrical matters, I feel that I have a sort of experience which warrants my speaking to you on the subject which I have chosen for this address.

Unfortunately, however, I find, like others in such a position as this, that a man who is busily engaged not only in teaching, but also in active practice in the engineering profession, finds very little time for putting forward his notions with either the literary finish or the completeness of treatment which his subject deserves.

Until a few years ago the construction of electrical instruments and machines and their erection and use were altogether in the hands of electricians who knew little about electricity, and who knew almost nothing of mechanical engineering. At present the best dynamos are made by experienced mechanical engineers who have somehow picked up a working knowledge of electricity, and for the last 10 years I have tried to impress upon young electricians the necessity which exists for their learning how to make working drawings and to make mechanical calculations, as well as for their being trained in the shops to use the hammer and chisel, and to learn the use of machine tools; in fact, that they must become good mechanical engineers as well as electricians. The electrical industries are more and more demanding the experience of the mechanical engineer. It is true that among the rank and file, for every hundred stokers, engine-drivers, fitters, and machine shop hands employed, there will always be needs for, perhaps, 10 men who may be called electrical plumbers; but I am not now thinking of the rank and file.

In 1860 it was almost unknown, and in 1870 it was very little known, that exact calculations might be made concerning electric phenomena—that is, that there was a science of electricity as distinguished from a mere natural history.

There were, indeed, publications in which the speculations of Franklin and other writers of from 70 to 100 years ago on the nature of electricity were fully entered into. Careful descriptions were given of rubbed glass-plate machines, of batteries of Leyden jars, the giving of shocks, the production of scenic effects by electric sparks, and the use of glass-legged stools. In general, such information was given as might be found useful by practical jokers. The information on magnetism was of much the same childish order. The department of voltaic electricity, or galvanism, as it was called, consisted of descriptions of various forms of voltaic cells, and of methods of joining cells together, so as to produce a maximum current in a circuit, with, perhaps, a description of the single-needle telegraph. The book was usually redeemed from worthlessness by some account being given of Faraday's experiments; but readers found that the main outcome of Faraday's work was the Ruhmkorff induction coil, whose important function was to illuminate Geissler's tubes for children's parties. In fact, it may be said that up to 1870 the writers of books, and nearly all the teachers of electricity at schools and colleges, remained in a state of ignorance of everything except what may be called a list of electric tricks.

And yet the science of electricity as we know it now had really been developed. The researches of Cavendish and Faraday and Joule were known to a few, and Sir W. Thomson's magnificent series of papers had been buried in journals and learned society transactions for, some of them, more than twenty years.

Now what distinguishes the engineer is this: he can design a thing which he knows will work if it is constructed exactly to his design. He makes exact calculations; but to do this he must have a quantitative knowledge of the phenomena he deals with. And the origin of Thomson's work, the origin of an exact knowledge of electrical phe-

nomena, was this: Thomson was an engineer, he was engaged in practical telegraphic work of such a kind as necessitated his knowing quantitatively about the phenomena he was dealing with, and, like an engineer, he proceeded to acquire the necessary information. Whereas the ordinary telegraph operator, the *quasi*-scientific experimenter and teacher, the popular lecturer, knew nothing of the fact that electricity can be measured. We cannot imagine a mechanical engineer regarding a few inches as being equal to a distance of some miles, or even of some thousands of miles, or his assuming that steel and brick are equally strong. We cannot imagine a grocer to confound an ounce of sugar with a ship's load of the same material; and yet these absurd notions give but too truthful an idea of the vagueness of the general want of definiteness which, till a few years ago, existed in the minds of nearly all men who called themselves practical electricians.

Observe that I am not contemning the labours of experimenters who did not have quantitative knowledge. In fact, the result of the work of such experimenters has very often been that an interesting problem has been put before the mathematical physicist, and it is sometimes forgotten that it is not the solver of a difficult problem, but really the settler of the problem, who is an inventor. I can throw ridicule upon the contrivances that I and many others have made in the past, but I know that the failure and partial success of such contrivances has taught us and the world how important it is to have an exact knowledge of the phenomena we deal with.

Such an exact knowledge of electricity is now readily obtainable, and it is well to consider how it was that this new engineering science was created with so much rapidity that in the last ten years a greater advance in its practical applications has been made than ever before in the history of the world.

Between 1860 and 1880, greatly in consequence of the work done by the Science and Art Department in this country, and its reflex action in other countries, some knowledge of the principles of electricity, which until then had only been known to a few people, became the property of thousands of mechanics, and it may almost be said that the rate of progress of electrical discovery became proportional to the number of people who had a little electrical knowledge. For example, what was wanted for the proper working on an arc electric light became known to many people, and in a short time hundreds of interesting methods of regulation were in use. The small magneto-electric machine, a toy for giving shocks and adding to the incomes of *quasi*-medical men, led to the machine of Wilde in 1866, which had electromagnets. In that year Varley, who was Thomson's partner, and others, made independently one of the grandest discoveries of the century, and presently a machine was in use which excited its own field-magnets, the type of all dynamos ever since. With this principle of Varley's, and using the form of armature employed by Pacinotti in 1860, Gramme invented, some time later than 1871, his famous dynamo which first revealed to the world how large might be the output of electrical power from a small machine. All the time from 1860 to 1883 there was an ever-increasing number of mechanics contriving and trying their inventions, and demanding a clearer knowledge of electricity, and at length some of the few who had the knowledge put their knowledge in simple language before the world. The result was that in 1883 we had not only the Gramme and Alteneck and Brush machines, but hundreds of others, which differed from one another mainly in mechanical construction. Even at this time there was no quantitative knowledge available concerning the magnetic circuit of the dynamo; but about five years ago Dr. Hopkinson, a well-known Whitworth scholar, discovered its law in seeking to improve that form of the Alteneck dynamo called the Edison, and showed that it was possible to have twice the output from a machine of given weight with a superior efficiency, so that now the simple laws not merely of the electric but of the magnetic circuit of a dynamo can be readily understood by any engineer, and in consequence the construction of dynamos and motors and other electrical contrivances is rapidly becoming as perfect as the construction of the modern steam-engine.

* Delivered before the Society by Prof. John Perry, D.Sc., F.R.S., on Friday evening, 11th October, 1889.

Let us give all honour to the experimenters who try all sorts of apparatus, some of them to be afterwards condemned as absurd, till they produce the germ of a useful invention; to the scientific men who use their mathematics and measuring instruments and give us exact laws. But we are not detracting from the honour due to these men when we also give credit to the mechanical engineers, without whom an invention would remain merely an interesting yet badly constructed toy.

What particularly attracted the attention of the mechanical engineer to the new science from 1878 to 1883 was the fact that by means of a dynamo, A, driven by a steam-engine or water wheel, and another dynamo, B, called a motor, and connecting wires between them, mechanical power in large quantities might be developed by B, with very little loss in transit. That there might be many motors, B, worked from one or many dynamos, A. That the motors might work printing presses or machine tools, or any other fixed machinery, or, again, railway carriages or tram cars, or trolley train in motion. And that electricity, the agent here employed, was not only capable of transmitting thousands of horse-power to immense distances with great economy, but it is an agent by means of which it is natural and easy to transmit signals and perform functions of a most complicated character at great distances, and so lends itself to most curious kinds of automatic working. They learnt also from Lane-Fox and Swan that the energy sent out by the same dynamo, A, could not only be used with accumulators, but be utilised in giving a most beautiful light distributed in any required way, and they knew that the greater part of the work to be done in this new industry was purely and simply mechanical engineering.

The mere fact that dynamos could convert several horse-power was in itself enough to produce a revolution in one's regard for electrical matters. Hitherto we had looked upon telegraphy as a beautiful adjunct to railway and other kinds of engineering; but the power required to operate the telegraphic apparatus at Valencia is one one-millionth of a horse-power, and really, the transmission of this power from America, accompanied as it was by a waste on the road of something like 99 per cent. of the total power sent in at America, could hardly be regarded as having any connection with mechanical engineering. Hitherto the mechanical engineer had concerned himself with the machinery required to draw iron and copper wires, to cover wires with silk or cotton, gutta-percha or indiarubber; with cable ships and their steam-engines and propelling apparatus, and with the specially contrived machines for paying out cable and picking it up. In a thousand ways the electrical industries required the help of mechanical engineering, but in the very same sort of ways so did the ladies' dressmaking industries. The new discovery really amounted to the discovery of a new department of mechanical engineering, for it soon became evident that the dynamo, A, was analogous with a force pump for water, and the motor, B, with a water pressure engine, and the wires represented the communicating pipes in a system of hydraulic transmission of power, and that, just as in the hydraulic system we could reduce the loss in transmission either by increasing the diameter of the pipes or by increasing the pressure, so in the electric system we could reduce the loss either by increasing the size of the conducting wires or by increasing the electric pressure.

Of course, it was at once seen that as dynamos must be driven, steam engines and boilers must be put up, and the belt, or rope, or friction gearing, or direct coupling employed in driving could differ very little from what are employed in driving fans, pumps, and other machinery. In arranging a central station there would be electric plumbing to be done, and some person must have a working knowledge of Ohm's law, which is a law easily understood by the hydraulic engineer. Given a little motor which you can cause to revolve in either direction by setting a handle on a tramcar, it does not seem to be a troublesome thing to arrange a method of driving the car from the motor; nor is it troublesome to drive an electric launch from a motor worked by accumulators.

And yet in the early days, what high salaries we had to pay for the minimum of knowledge of electric plumbing,

combined with nearly the minimum of mechanical engineering knowledge! How much trouble we had over the gearing connecting an electric motor and the wheels of a tramcar! Well, those expensive days are over, the days of advertisement and Stock Exchange success, of making bricks without straw. Various educational institutions have now given us the straw, and as a matter of fact we see that the best man to take charge of a system of distributing light and power is an experienced mechanical engineer who possesses a good working knowledge of the simple laws which govern electric distribution in wires. Of course, this is on the assumption that the engineer has not to construct his own dynamos and lamps, and switches and wires, and motors, and accumulators and transformers. Just one year ago I impressed this on an experienced engineer who knew almost nothing about electricity. He now knows how to apply Ohm's law in all necessary ways in the large scheme which he is carrying out, and he has a better practical knowledge of electric distribution and of all the calculations to be made than any of the electricians in his employment.

When I say that the mechanical engineer ought to learn Ohm's law, I mean that he ought to pass through a proper laboratory course, and make numerical calculations, in which he will illustrate all sorts of ways in which this simple-looking law is applicable. A knowledge of what is meant by amperes, volts, ohms, and watts cannot be obtained merely by listening to lectures or by reading. Just as a little use of a watch, of a 2ft. rule, of a spring balance give exact practical notions of the measurement of time, of distance, and of force, so the use of an ammeter and voltmeter will give exact practical notions about Ohm's law and electrical measurements generally.

And now as to the construction and manufacture of electrical appliances. Given perfect working drawings of any machine or instrument, with necessary instructions, the manufacture may be carried on by the ordinary foremen and workmen of any engineering shop. If I can be sure that my instructions shall be carefully carried out, I prefer to have my work done at such a shop. Only if something is specified as charcoal iron it must not be made of Siemens steel, as, I am sorry to say, it very often is, or of malleable cast-iron, as it sometimes is. If plates are shown separated by Willesden paper, then Willesden paper, and no other material must be used. As workmen obtain more electrical information, and, therefore, understand why such instructions are given, there will be more certainty of their being attended to. This manufacture may really be said to be altogether in the hands of the mechanical engineer, and if he would only try to gain what is easily gained—a working knowledge of electricity and magnetism—the design of electrical contrivances would also be in his hands; for even now, many electricians are not sufficiently alive to the importance of drawing. One gentleman I know, who has designed many successful instruments and machines, followed this procedure: He went to his instrument maker and gave careful instructions, illustrated by sketches, as to the making of a new instrument. At the end of a fortnight he went to see the instrument as made, pointed out that it was not at all what he wanted, and gave better instructions for a second, for, indeed, his own ideas were now clearer; went again and recommended changes to be made, and again and again, sometimes seven visits, with seven radical changes, taking place before the instrument was satisfactory. It required ocular demonstration to convince him that one could have every detail exactly as one wanted it in the first instrument made to a working drawing.

I am sorry to say that I have found it impossible yet to depend upon the good mechanical draughtsman to design new electrical appliances. You may explain to him most carefully what you want, and look over his drawing half-a-dozen times, but wrong details are sure to escape your notice, and his own knowledge of electrical matters is as yet very poor. The man who designs a new electric appliance must be a good mechanical engineer, which assumes that he is himself a good draughtsman, and he must also be a good electrician, and it only leads to fitting and trying and partial failures for two men with the two qualifications to work together, each trying to supply the deficiencies of the other. The reasons for this may become more evident if I consider with you the design of some one electrical

contrivance, and nothing is better for our purpose than a dynamo.

A dynamo consists of an armature wound with insulated wire, revolving in the field of a fixed electromagnet. Now, the disturbance of the fixed and movable iron is what Dr. Hopkinson has given us exact simple information about, and the sizes of the iron parts must be settled first. But the magnetic laws, although easily stated, cannot be understood by the designer and instinctively applied, all so simple as they seem, without a considerable amount of study and numerical calculation. I will not here enter into them, but it may be mentioned that although it seems very easy, it is really not very easy to get into the way of using the centimetre (about two-fifths of an inch) as the unit of length. I have tried in various ways to avoid using this unit, but I am sorry to say that in these calculations all measurements must be taken in centimetres, and the dynamo designer must get used to thinking of distances, not in inches, but in centimetres. There is no doubt that this is a great affliction.

What comes very easy to the engineer is the notion of and the measurement of the efficiency of a dynamo—that is, the useful output of electrical power divided by the mechanical power actually given to the machine. Power is wasted in the machine: 1st, at the journals in mechanical friction; 2nd, in air friction; 3rd, in what may be called magnetic friction, and unless care is taken in properly dividing and insulating the iron and other metal of the armature to prevent induced currents circulating in it, this metal, and sometimes the metal of the fixed magnet at its pole-pieces, gets greatly heated; 4th, in electric friction in the wires of the armature, because electric currents flow through them. It is, indeed, this loss of energy, or, rather, the rise of temperature produced, which determines the output possible from a given size of machine; 5th, a loss due to the reversal of current continually going on in the coils of the armature as they pass the brushes.

Now, the mechanical engineer may safely be left to the problem: "What is the best length and shape of the journals of a dynamo?" Even in this, however, he will find special conditions presented to him. For example, the rotating part of a dynamo is always, or may always be made to be, well balanced. The speed is usually high. Sometimes the dynamo is driven direct, and if a flexible coupling be not employed, considerable pressure may be produced at the bearings. Or it may be driven by belting to its overhanging pulley, and again we have to consider the pressures. Sometimes we must consider the possible springing of the spindle under centrifugal force.

Three years ago I had careful measurements made of the diameters, lengths, and speeds of the journals of all the dynamos and motors belonging to a certain educational institute. There were 12 altogether, and they were all from well-known electrical engineers. Well, I was unable to find any law connecting the dimensions, and speeds, and weights, not merely of the whole 12, but even of any group of them. Then, as to oiling, we have not merely to think of the necessity for a regular supply of oil, but of preventing this oil from penetrating the neighbouring commutator. A very little oil on the commutator surface is not objectionable, but in certain places, where there are short spaces of surface insulation, if a spark once passes through oil it may leave a carbonised residue, which destroys the electric insulation.

It is important that the dynamo should be efficient, but it is even more important that it should be *durable*. It is true that efficiency and durability go together to some extent. For example, it is difficult to imagine that a machine shall waste much energy by the fifth cause already mentioned, which leads to sparking at the brushes, or by friction at the bearings, and yet be very durable. In some respects, however, they are antagonistic, and here we see why two men—one solely mechanical, and the other solely electrical—are unable to assist one another much, and that one man must combine in himself the necessary mechanical and electrical knowledge. Everything must be as strong as possible, yet there must be good electric insulation everywhere. Again, strength of armature seems antagonistic to the necessity for great division of the iron, so as to avoid magnetic friction. The electrician wants as great circumferential speed as possible in the armature, but the

mechanic points out that considerations of centrifugal force will only allow of higher speeds, as the diameter of the armature is greater. The electrician retorts that for drum or cylinder armatures to be of large diameter, the size and weight of the whole machine must be great, for certain magnetic reasons.

It is not merely in designing the general shape of a dynamo, then, that the engineer requires a working knowledge of the laws of magnetism, but even in such details as the method of dividing the iron of his armature so that no loss shall occur by the third cause given above—that is, by Foucault currents. He must have such an acquaintance with the subject that it is impossible for him to make a mistake without experiencing that instinctive repugnance for what he has done which a good draughtsman experiences in such matters as fillets in castings and bolts and nuts.

It is difficult for us to understand why young Watt wondered at the possible pressure of steam on the lid of the mythical kettle. Yet there are many millwrights now existing who cannot comprehend the pressure of steam inside a vessel. It is in no respect more wonderful than the force which resists the motion of a wire through the magnetic field of a dynamo. Here, for example, is the copper wire of the armature of a certain dynamo. When the armature is revolving, and the proper current is flowing, there is a total force on this piece of wire, resisting its motion, of 8lb., and the centrifugal force on it is 24lb. If you carefully study these figures, you will understand why it is that the construction of an armature has become a part of mechanical engineering. Ten years ago dynamos were not very powerful, and the resisting or driving force on each piece of wire was not very great, so that the friction between insulated wire and the iron core on which it was coiled, and, again, the friction between this wound core and a wooden centre which acted as a wedge in attaching the core to the spindle, could be relied upon with certainty. In modern machines, however, such methods of fastening would be childish to think of. But difficult as it is at first to think of these resisting and driving forces on bits of wire moving through the atmosphere, the mechanic has more difficulty in comprehending how great these forces may suddenly become in an accidentally short-circuited machine. All at once the wires have, perhaps, ten or twenty times their usual greatest currents, and their motion is resisted by forces ten or twenty times as great as usual. They had been going through the atmosphere for days or weeks at a regular rate, their currents were just great enough to keep them safely warm, when suddenly 10 to 20 times as much resistance to motion occurs, and heat is generated at 100 to 400 times as great a rate in them. Happily, in direct-driven machines the engine is usually pulled up—that is, the dynamo brakes the engine—and in belt-driven machines the belts slip; but enormously increased stresses do occur for a short time, and the possibility of their occurrence must be taken into account. If this is important in dynamos where excessive stresses occur only accidentally, think how important it must be in motors where it may often happen that the full electric pressure is turned on even when the machine is at rest or moving slowly. I remember that, when putting up a telfer line about four years ago, I became quite desperate on account of the failure of one kind of motor after another, until at length I used the Immisch motor, which was designed by a man who combined mechanical and electrical experience. These motors have worked for years now in the charge of Sussex labourers, more or less exposed to all kinds of weather without renewal.

Now, if you examine the armature of the Immisch motor you will see that the wires are bound down, almost covered, in fact, with many bands of phosphor-bronze wire, and that they are wound among numerous projections of iron to give the necessary strength. You can observe in the specimen I show how strong-looking these projections are. In this armature of 3in. diameter there are four driving discs, with altogether about 48 projections of iron, each being a cube of nearly $\frac{1}{4}$ in. edge. I am told by the maker that on one occasion in early days, when cast iron was used, everyone of those 48 projections was suddenly stripped off in the natural working of a machine. I know of nothing which has more impressed me than this with

the fact that the electrical industries require the experience of mechanical engineers.

Now, everyone of these numerous copper wires is subjected to such forces as I have described, and yet no one wire must touch another metallicly, they must be insulated from one another, and also from the iron core of the armature, and the whole armature must be strongly and rigidly attached to its spindle, and yet the fastenings must not take up much valuable space. I have also said that the iron core must be of numerous thin plates, which do not touch each other or the fastenings to the spindle metallicly. Again, the armature must allow air to pass through it fairly well to keep the wires cool, and we must allow for local expansions and contractions by heat; also the smaller the clearance between the revolving armature and the fixed magnet, the greater is the output of the machine. I know of nothing which requires a more general exact knowledge of the mechanical, electrical, and other properties of materials, and the strength and stiffness of structures which may be subjected to local heating, than the design of the armature of a dynamo. Why, even the 72 fastenings of the wires to the 72 pieces of the commutator have been the source of much trouble, for these fastening pieces are themselves passing through some magnetic fields, and what with the magnetic resistance to their motion and their centrifugal force, and a constant vibration to which they are subjected, their arrangement presents not one but numerous new problems to the mechanical engineer.

Now, to describe the design of a dynamo more in detail would only weary you, so I will finish this part of my subject by referring to the commutator. Here is nearly a cylindric body. It is built up of 72 separate pieces, all separated from one another by thin pieces of insulating material. Not only must there be no metallic contact between piece and piece, but between any piece and the spindle to which the commutator is strongly and rigidly fastened. Now, no insulating material is very strong, it is apt to warp with heat, yet the whole structure must be strong and rigid. As it is rubbed on the outside by two metallic brushes, it is important to reduce friction by having it not too large. Again, for the prevention of sparking, the pieces ought to be of copper, but for wear, under the action of the rubbing brushes, the pieces ought to be of some material more approaching phosphor-bronze in character. I will not refer to the construction of the holders of these brushes, which must be adjustable in position, and yet rigid in any position; nor to the brushes themselves, which must be insulated from one another, and must touch gently, but certainly, over nearly the whole length of each commutator piece as it passes. Above all, we must remember that the machine must often be capable of running continuously, day and night, for months.

I need hardly say that the man who designs a dynamo machine ought to know something of how his design will be carried out in the shops. Again, his design will not be quite the same if only one machine is to be made as it would be if hundreds or thousands were to be made, and the principle of unchangeableness of parts were to be applicable. For in this case, to take one detail, instead of casting a commutator piece of phosphor bronze, or making experiments to find how little is the quantity of silver that one must add to copper so that a good casting of the piece may be possible, he would probably have a machine which would roll out the wedge-shaped commutator pieces in one long strip, and this would necessitate a change of design in the fastenings. His copper winding would be curiously flat in section. He would design the iron pieces of which his armature core is composed so that they might be stamped out, and he would alter his design so that the manufacturer could make large use of stamping and forging and milling machines, and in many other ways he would use his mechanical engineering knowledge for the purpose of facilitating manufacture.

You may perhaps think that I have dwelt too long upon my statement that an electrician must be a good mechanical engineer, or that applied electricity is merely a branch of mechanical engineering. Before Watt's time there were mechanical engineers, and when the new branch was annexed, it was not called heat engineering, although all mechanical engineers were, after that period, expected to

know with such exactness as was then possible the laws of heat. Gentlemen, we are all specialists now; we devote ourselves to particular branches of our profession, but, all the time, each of us has a general knowledge of other branches of the profession. Each of you has some special knowledge, either of hydraulic machinery, or stationary engines, or locomotive engines, or gas-engines, or marine-engines, or boiler making, or cranes and hoists, or machine tools, or some other branch of the profession. But if a man called himself a mechanical engineer who had not some general knowledge of all these branches, would you not look upon him with a certain amount of contempt? And you would be right, for the scientific principles of all the branches and their application and the special contrivances of all, enter often in most unexpected ways into one's own special work. The gist of this address is that the electrician has become a member of your profession. My own belief is that 10 years hence he will be of as much importance in the profession as the steam-engine engineer, and that no man having a right to call himself an engineer will be without a good working knowledge of electricity. For this knowledge will give him a new weapon, which he can wield with unexampled certainty, and which, in my opinion, will develop into the most powerful weapon at his command. I could already give you many examples of the way in which a knowledge of electricity will enable you to develop your special branches of engineering, such as that of electric welding and the electric tempering of steel.

But I will end this address by asking you to put some faith in the following statement: You know that the best steam-engine engineers never expect to obtain more than one-tenth of the total energy of coal as actually given out by a steam-engine, and that in some small engines only one one-hundredth is given out. The idea that we are wasting at an enormous rate the energy stored up for us in coal by nature during millions of years is one that sometimes becomes oppressively horrible. Now, I pointed out in 1881 that if coal or gas were burnt in a voltaic cell as zinc is burnt, and an electromotor were used, we could utilise as mechanical energy not merely one-tenth, but nearly nine-tenths of the energy of coal. I pointed out then that coal-gas could be burnt in this way, but there were two difficulties—1st, the apparatus required was too large per horsepower developed; 2nd, the apparatus required was too expensive. The first of these difficulties has already been got over by a correspondent of mine, who is in some sense my partner. We see our way to developing one useful horsepower per cubic foot of volume of apparatus. Unfortunately, the difficulty of expense still remains. But I am firmly convinced, and I have good reason for my belief, that all the difficulties will be got rid of, and that coal will actually be burnt in this way. Even to those of you who may not be troubled about the general question of economy, the mere possibility of an armour-clad being able to carry enough coal for a voyage at full speed round the world, must appear to be an important result. With the ideas of steamships carrying very much greater cargoes and going at greater speeds, and other ideas which must strike you all as the result of the above economy, I will leave you, but I must confess that the general question of economy and its influence on the progress of the race appeals to me with infinitely greater force.

THE AGE OF WONDERS.—The wonderful tales and dreams of the old alchemists and astrologers are as nothing to the actualities and future possibilities of electricity. The immense increase of material prosperity which resulted from the invention of the steam-engine will pale before the coming applications, in world-wide directions, of electric power. The only danger is that the whole human race may not partake of this increase in material benefits, but that the benefits shall be too much concentrated in the hands of individuals, and those who are now badly off be then no better. The share of humanity as a whole in the vast benefits of Nature's secrets ought never to be forgotten in the struggle for existence, but the application should in all ways be encouraged by those to whom the guidance is entrusted, in such a manner that the generality may share in Nature's gift to a family of which we are all members.

THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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Specimen copies of the paper will be sent on request.

PROF. PERRY'S ADDRESS.

The inaugural address to the Junior Engineering Society is full of debateable matter. Two men—nay, ten or a hundred—given the same book in Greek or Latin, or any other foreign language, will translate differently. They all have the same words, the same facts, but differ as to the meaning to be attached to them. Prof. Perry advances certain conclusions, but if his facts are disputed, it goes without saying, so are his conclusions. We think wrong deductions have been drawn, and shall not hesitate to give our views. Before, however, coming to controversial subjects, it may be well to state that we have no difference of opinion with Prof. Perry, that the best electrical engineer must necessarily be the best mechanical engineer who has superposed upon his mechanical training a knowledge of electricity, both as regards theory and practice. No doubt this was about all Prof. Perry really wanted to say, but he had to fill up a certain amount of time saying something, and, as is often the case under such circumstances, the something said will not bear strict examination. Better, however, to say our interpretation of history is not the same as the president's. Examine for a moment the statement, "Until a few years ago the construction of electrical instruments and machines and their erection and use were altogether in the hands of electricians who knew little about electricity, and who knew almost nothing of mechanical engineering."

There is going to be—some day or other—a wonderful extension of our knowledge into the domain of molecular physics. Is it a matter of opprobrium now that neither electrical nor mechanical engineers are engaged in constructing machines that will not and cannot be designed till that development comes? Will it be a matter for regret then that electrical and mechanical engineers are not now so employed? Well, it may be a matter for regret, because we may always regret that development did not happen earlier, but a matter for denunciation, never. Previous to 1850, what electrical apparatus called for the aid of the mechanical engineer? There were telegraph instruments—work for a clockmaker, but nothing else. Would you have had Stephenson or Brunel turn telegraph instrument maker? Between 1850 and 1870 land telegraphy was supplemented by submarine, which required picking up and laying down gear. It is news to us that this gear was designed, constructed, or erected without the aid of the mechanical engineer. Are there, were there no mechanical engineers at Silvertown, at Siemens, at Johnson and Phillips, at the T. C. and M. Works? The fact is indisputable, that during the period we have referred to mechanical engineers were not wanted to construct purely electrical (almost entirely telegraphic) apparatus, though they were wanted and were employed

to construct the gear referred to. Now we come to the period since 1870, the period of the dynamo. Without a single exception, so far as we are aware, the design and construction of these machines has been by others than electricians. The electrician pure and simple has failed ignominiously, absolutely, and the mechanical engineer has done the work. Gramme was not an electrician, nor was Bürgin, nor Crompton, nor Brush, nor Kapp, nor Schuckert, nor Mather and Platt, nor Elwell-Parker, nor Edison. The electrician might keep to his own field without damage to electrical engineering considered as a branch of engineering; he is required to find out the electrical properties and conditions of bodies, and to give this information to the mechanical engineer. The latter will utilise the information and construct his appliances accordingly, though through the ignorance of the pure electrician, or his inability to do aught but float about in the clouds of theories and conjectures, the mechanical engineer may have to do work and get results that should be at his command without seeking them. The electrician, and especially the old-fashioned scholastic electrician, is a man seeking he knows not what by means he knows not how. Our contention, then, is that mechanical engineers were not wanted among electrical apparatus (except so far as regards cable gear) till Gramme and Paul Jablochhoff opened the gate and showed there was a future branch of engineering to be called electrical engineering, giving a date, say 1878. Since then nobody denies but the proper man is the mechanical engineer, who requires, for the construction of a dynamo, a by no means extensive knowledge of electricity.

There is another question raised by Prof. Perry which permits of a difference of opinion. We do not believe the Science and Art Department has contributed one iota to the real backbone of electrical engineering—it may have added to the long list of electrical plumbers. The men who have founded an industry are Gramme, Brush, Jablochhoff, Swan, Lane-Fox, Crompton, and the younger generation—Hopkinson, Kapp, Mordey, Esson—to whom must be added the business managers, and where does the Science and Art Department come in among these? Why, the Science and Art Department is even now a century behind the time. Prof. Perry is hard enough upon the older textbooks, though there have always been books which have been excellent of their kind, but the thousand and one books issued under the syllabus of the Science and Art Department ought, in the majority of cases, to be burnt by the common hangman. Further, although what may be called the mathematics of electricity had been developed by Green, by Thomson, by Maxwell, and others, and although the work of these men is invaluable, not two per cent. of the men who have developed the industry

of electrical engineering can understand what these giant intellects have written. For the production of good work a very moderate amount of the results of these mathematical investigations is required. Our purpose is not to disparage these mathematical investigations, but rather to suggest that the pioneers of electrical engineering deserve a higher niche in the temple of fame that is usually accorded them. No doubt almost everything is in Maxwell's books, so, at least, the electricians tell us, but we never heard of a person designing a machine or doing very much to perfect one though he had Maxwell at his fingers' ends.

OBITUARY NOTICES.

SIR DANIEL GOOCH.

We regret to announce that Sir Daniel Gooch, chairman of the Great Western Railway Company, died at Clewer Park, Windsor, on Monday afternoon, after a protracted illness. Sir Daniel was born at Bedlington, Northumberland, in 1815, and studied as an engineer at Newcastle under Robert Stephenson. After being engaged for some time in connection with the large iron works of South Wales, he became chief locomotive engineer to the Great Western Railway, a position which he held for 27 years, and afterwards became chairman of that company. He was also a director of the Anglo-American Telegraph Company, Limited; the Eastern and South African Telegraph Company, Limited; the Telegraph Construction and Maintenance Company, Limited; the Globe Telegraph and Trust Company, Limited; and an *ex-officio* director of the Bala and Festiniog Railway Company, Birkenhead Railway Company, Llanelly Railway and Dock Company, Newent Railway Company, Oldbury Railway Company, Princetown Railway Company, Ross and Ledbury Railway Company, Tiverton and North Devon Railway Company, and a trustee of the Submarine Cables Trust.

Sir Daniel was one of the original shareholders in the "Great Eastern," and was for some time chairman of the company that owned that unfortunate vessel. He took an active part in promoting Atlantic telegraphy when it was generally regarded as a chimera, and it was in recognition of his efforts in connection with that enterprise that he was made a baronet in 1866.

DR. JOULE.

James Prescott Joule died at Sale, near Manchester, on Friday, October 11, after many years of ill-health. Very few indeed who read this announcement will realise how great a man has passed away; and yet it is admitted by those most competent to judge that his name must be classed alongside of the great original workers in science. Many who have never heard of the name of Dr. Joule have heard of the "Mechanical Equivalent of Heat," a phrase, it is to be feared, that to the majority of even intelligent people has little meaning. It is mainly on the discovery of this "mechanical equivalent" that the late Dr. Joule's title to fame rests. Joule was born at Salford, Manchester, on Christmas Eve, 1818, so that he has died at a ripe old age. He was so delicate that he could not be sent to school, and so was privately educated at home. Both his father and grandfather were brewers, and young Joule and his brother also entered the business, though James soon became so absorbed in scientific investigations that he practically left the brewery to others. Soon after entering the brewery, about the age of 15, he and his brother were sent by their father to the great chemist Dalton, the propounder of the atomic theory, in order to learn chemistry. One can easily fancy the influence that contact with a mind like Dalton's would have on a youth like Joule. He seems

to have been at once caught with the enthusiasm for scientific research, and soon, with the rudest apparatus, began to make experiments of his own, mainly on the chemical constitution of gases and on the relations between chemical action and electricity. One of his first published papers was on a new electro-magnetic engine, which he described at the age of 19. The amount and variety of his work since then may be inferred from the fact that in the Royal Society List there are the titles of 97 papers, besides over 20 other important papers on researches undertaken by him in conjunction with Sir William Thomson, Sir Lyon Playfair, and Dr. Scoresby. In conducting his many experiments in electro-magnetism he had met with "the difficulty, if not impossibility, of understanding experiments, and comparing them with one another, which arises in general from incomplete descriptions of apparatus, and from the arbitrary and vague numbers which are used to characterise electric currents. . . . I have therefore determined for my own part to abandon my old quantity numbers, and to express my results on the basis of a unit which shall be at once scientific and convenient." He set himself to devise an accurate method of measuring a unit-quantity of electricity, which he took to be the quantity required to decompose nine grains of water. He went on to devise many improvements in galvanometers and to carry out a vast variety of ingenious experiments in the various aspects of electricity, and was thus led in 1841 and 1842 to lay the foundation of a new department of physical science, thermodynamics, in which so much good work has been done since. Meantime he had been speculating on the conversion of chemical energy into heat, and in 1840, 1841, and 1842 he gave accounts of a number of experiments, all leading up the great discovery of the mechanical equivalent of heat. This discovery in its earliest form was first announced at the Cork meeting of the British Association in 1843, in a paper on "The Calorific Effects of Magneto-Electricity, and on the Mechanical Value of Heat." In it, among other things, he said: "I have lately found experimentally that heat is evolved by the passage of water through narrow tubes. . . . I obtained 1deg. of heat per pound of water from a mechanical force capable of raising about 770lb. to the height of 1ft. . . . I shall lose no time in repeating and extending these experiments, being satisfied that the grand agents of nature are, by the Creator's fiat, indestructible, and that, whatever mechanical force is expended, an exact equivalent of heat is always obtained." The importance of the announcement it is impossible to overrate. Of course, others, at home and abroad, had been working in the same direction, just as had been the case before Darwin announced his great discovery. But, though at first it was slowly and somewhat grudgingly recognised by his fellow-students, Joule's discovery made its way surely and is now recognised as one of the ruling constants of science. Of course, he continued to work at and to perfect his mechanical equivalent, and in a paper to the Royal Society in 1878 he gave the results of a fresh determination, according to which the quantity of work required to be expended in order to raise the temperature of 1lb. of water, weighed in vacuum, from 60deg. to 61deg. Fahrenheit, is 772.55 foot-pounds of work, at the sea level, and in the latitude of Greenwich. Joule's great experiment has been repeated by many hands and in many forms, and on great scales, but nothing has shaken the truth of the discovery. As will be seen in Sir William Grove's great treatise on the "Correlation of the Physical Forces," this thoroughly grounded theory of the mechanical equivalent of heat is an important link in the chain of proof that all forms of energy are really manifestations of one force. But the scientific bearings of Joule's great discovery are of the widest and profoundest character; and he is entitled to be placed among the greatest of original workers in pure science. But the practical results which have accrued from his theory have been of the most useful and beneficent kind. They have enabled our engineers to improve their machinery along lines of precision not otherwise attainable; while the amount saved in the application of heat must have amounted to millions. Joule continued his

scientific investigations till very near the end, and, varied and important as they were, they cannot be entered into here. He lived the most retired life, partly from weak health and partly from his native modesty; and so it happens that one of the greatest of Darwin's contemporaries was hardly known to the outside world. He was honoured, among those whose opinions alone he valued, at home and abroad. Gold medals and other marks of appreciation were showered upon him, including those of the Royal Society and Society of Arts. In 1878 her Majesty, through Lord Beaconsfield, conferred upon him a pension of £200 a year; and few pensions were ever better deserved. Dr. Joule married, in 1847, Miss Amelia Grimes, of Liverpool, who died in 1856, leaving a son and daughter, who survive.—*Times*.

NEW YORK NOTES.

(FROM OUR SPECIAL CORRESPONDENT.)

Those "Deadly Wires" Again.
Mr. Brown Quiet; Mr. Heinrichs Busy.
The Mayor Receives Advice from an "Electrical Expert."
The Firemen and Electric Lighting.
Captain Brophy on Safety and Insulation.
Dr. Louis Bell on Traction by Storage Batteries.
Original Insurance Rules for Electric Light Wires.

NEW YORK, October 5, 1889.

The "deadly wires" have once more had their little innings this week. Two days ago a large van loaded with a new electric tramcar, bound for Brooklyn, passed through the Bowery. The top of the car caught some electric light wires suspended from the structure of the elevated railway and dragged them from their fastenings. The wires fell into the street, and a large crowd of passers-by gathered to enjoy the sport of watching the drivers of the various vehicles trying to avoid the fallen wires. One wire got foul of a tramcar, and the conductor, on grasping the wire to free it, received a shock which knocked him down. One of the horses of the next tram stepped on a wire, and was thrown to the ground by the shock. Several other similar incidents occurred before the employes of the electric light companies arrived and cut away the loose wires.

Mr. Harold P. Brown has lately been keeping pretty quiet. No further developments have been recorded with regard to the famous letters in spite of the 1,000dols. reward offered for the discovery of the "thief" and the return of the documents. Mr. Brown's friend and coadjutor, Mr. C. T. Heinrichs, however, has been keeping the ball rolling. A short time ago an evening paper printed an article by this "well-known electrical expert" on the subject of one of the recent deaths by electricity; the article was illustrated by diagrams and undertook to demonstrate exactly how much "electrical energy" (expressed in volts) was expended upon the body and nerves of the man who was killed, and how much in the contacts between his hands and the wires. Quite recently Mr. Heinrichs has addressed a lengthy communication to the Mayor of New York, lecturing that official about "the deadly nature of the high voltage of electric currents used in this city." He also declared "a great number of professional electricians and scientists have rashly or imprudently misrepresented the causes and circumstances of the accidents by high-voltage currents, and pretended to be unable to tell approximately the voltage of the current or the electrical energy which has or will cause death to human beings." Mr. Heinrichs should be satisfied with his own ability to compute exactly to a fraction of a volt the "electrical energy expended upon the body and nerves" of a man who grasped the wires of a circuit carrying a current at 2,000 volts pressure, and not expect too much from others; one such "electrical expert" is quite enough in these sensational times. Besides Mr. Heinrichs is himself the inventor of an arc system which, so far, has not given much light, therefore his diatribe against what he styles "the avarice of the great high-voltage combination" can scarcely be looked upon as altogether disinterested.

At a recent meeting of the National Association of Fire Engineers, Captain Brophy, the inspector of the New England Insurance Exchange, read a paper, entitled, "How

Can Electric Wires be Run into Buildings so as to Ensure Safety from Fires? Also the Best Insulation for the Same." The paper is very long, and is chiefly devoted to a lucid description, technical terms being studiously avoided, of the different classes of electric light circuits, and to pointing out under what conditions they are dangerous to health and property. Referring to the high-tension alternating system, Captain Brophy says: "In view of the somewhat increased danger attending this system of lighting, I would advise, first that these circuits be so constructed that they can be readily distinguished from the low-tension direct system of incandescent lighting, and the series or arc lighting system. I would also have them under the immediate control of the fire department by means of cut-off switches placed at intervals along the entire line, so that the wires could be disconnected from the dynamo at any point where they might interfere with the work of the department during the progress of a fire. Then they could be handled or cut without danger." Only a small portion of the paper touches upon the question of insulation, and all the precautions recommended are already well known and generally adopted. The following sentence is worth quoting: "A safe rule to apply to all wires concealed between floors and ceilings, and behind partitions, is to use the same care as would be necessary were they not covered with any insulation at all." A very safe rule indeed, but I wonder how many contractors observe it.

Dr. Louis Bell is the author of an excellent article on "The Present State of Traction by Storage Batteries." Dr. Bell says that the reports recently published on this subject lack importance from the omission of all details that could possibly give a basis for an estimate of the value of the system, and that we are so far ignorant as to the first cost and probable yearly depreciation of the batteries, the efficiency of the system, and the cost of operation compared with horses, cable, and other electrical systems. The difficulty of estimating the efficiency of the batteries on account of its variation with the rate of discharge is the first point touched on, and Dr. Bell says that experiments on this subject are greatly needed. Dr. Bell estimates the efficiency of the storage battery system in the following manner. He places the efficiency from steam to electricity at the charging station at 75 per cent., that of the motors at the same figure, and that of the accumulators at 70 per cent., thus arriving at an efficiency of the whole system of 40 per cent. He compares this figure with that given for the direct supply systems by Mr. G.W. Mansfield, who placed it at a little under 50 per cent. for ordinary cases. "If this comparison seems unfair to the storage battery," continues Dr. Bell, "I can only reply that I am a believer in the ultimate success of the accumulator, and would hail with joy any authentic tests disproving the above estimate." Following this, Dr. Bell points out that in the storage system much power is wasted on account of the dead weight of the battery itself. The fully equipped Julien car weighs 14,000lb., of which 3,800 is battery. The same size of Sprague car weighs only 6,400lb., of which about 2,400 is motor apparatus. Dr. Bell treats of the life of the batteries and the expense of maintenance, and on both these points says much that is discouraging to friends of the accumulator. Summing up, he says: "All that can fairly be said is that it yet remains to be proved that the storage system can be operated as cheaply as horses. So long as we have to rely on the heavy and rather perishable lead accumulator, proof will be hard to maintain. The storage system has certain great merits which especially commend it for city work. It requires only a track; each car is an independent unit, and no accident can cripple the system. The service can be made thoroughly reliable. Its economy is at present doubtful; it costs distinctly more than traction by direct supply, and probably more than traction by horses, unless under specially favourable circumstances."

The chief surveyor of the Pacific Insurance Union, in reply to a recent enquiry for information concerning incandescent lighting and its relation to fire risks on the Pacific Coast, stated that although the Pacific Insurance Union had not adopted any rules in reference to lighting by electricity, still, the following general requirements should be insisted upon: "The conducting capacity of all

circuits for electric lighting must be sufficient to prevent undue heating of the wires; in no case should the temperature of the conductor exceed 18deg. Fahr. All wires must be covered with some material of high insulating power. All joints must be so made that a perfectly secure connection will be ensured, and they must not be soldered, but must be covered with some insulating substance. All joints must not be soldered, but conductors should be constructed with as few joints as possible." What would the I.E.E. committee say to these "general requirements"?

INTERIM REPORT OF THE COMMITTEE ON "CERTAIN MOLECULAR PHENOMENA ASSO- CIATED WITH THE MAGNETISATION OF IRON."*

At the meeting of the British Association at Bradford, in 1873, a paper was read by the secretary of this committee, and subsequently published in the *Philosophical Magazine* for December, 1873, "On certain remarkable molecular changes occurring in iron wire at a low red heat." In this paper the phenomenon known as the *recalcence* of iron was first published, it having been discovered by the author early in September, 1873. At the suggestion of the late Prof. Balfour Stewart, a small committee was appointed, of which Prof. Barrett was appointed secretary, to investigate and report on recalcence and other molecular phenomena attending magnetisation. This committee had some meetings, and a good deal of unpublished experimental work was done by the secretary, but no quite satisfactory explanation of the main point, the phenomenon of recalcence, was arrived at. It was evidently not a surface phenomenon, not a mere effect of conductivity as had been suggested, but arose from some molecular change in the material itself. The lamented death of the two principal members of the committee, Profs. Clerk Maxwell and Balfour Stewart, left the matter in abeyance, and the committee lapsed before a report was presented. Recently, however, the committee has been reappointed, and now consists of Prof. Fitzgerald as chairman, Messrs. Trouton and Newall, and Prof. Barrett as secretary. Owing to various causes, it is not proposed on the present occasion to do more than present a formal interim report, reserving to next year the full report of the committee.

So much work has of late been done on the general subject of the molecular phenomena attending magnetisation, that it would now be beyond the scope of the committee adequately to report on the whole matter. We propose, therefore, in the first instance, to confine our report to those phenomena accompanying the so-called critical temperature of iron—that point in, or near, which the magnetic state is lost in heating and regained on cooling. Here, at a dull red heat a series of profound and remarkable changes occur in iron and steel, to which attention was called in the paper referred to above. The principal points in that paper were as follows:

1. Mr. Gore, in 1869 had discovered that a momentary *elongation* of iron occurred in cooling after heating a wire of that metal to a white heat. In 1873 the author found a similar but reverse action took place in *heating* the wire.
2. This anomalous deportment was found, both in heating and cooling approximately, to coincide with, on the one hand, the *loss*, and on the other with the *resumption* of the magnetic state of iron or steel.
3. At the critical temperature the wire, having cooled down to a dull red heat, suddenly flashed into a bright glow; likewise during the *heating* of the wire the temperature remains stationary for a short time when the critical temperature is reached; a rise in the specific heat of iron and steel therefore occurs at the critical temperature.
4. A curious crepitating sound occurs at the critical temperature, similar to that heard in the magnetisation of iron, or in the production of the scales of oxide on the wire.
5. Prof. Tait's remarkable thermo-electric change in iron occurs at this same temperature.
6. Hard iron wire and

* Read by Prof. Barrett at the meeting of the British Association at Newcastle.

steel wire exhibit recalcence, but certain specimens of good soft iron failed to show it, and even in the wire that exhibit it the phenomenon grows less marked after repeated heating and cooling."

To these observations may be added that a recent investigation by the secretary of the committee on the properties of 14 per cent. manganese steel wire (*Proceedings*, Royal Dublin Society, December, 1886) shows that this body, which is almost a non-magnetic metal, does not exhibit the anomalous deportment observed in ordinary steel wire. This fact is of considerable interest, as linking the foregoing phenomena more closely with the magnetic state of iron and steel.

Estimating the temperature of the critical point approximately from the expansion of platinum brought to the same degree of redness, it was found, some years ago, to be not above 800deg. C. The recent admirable investigation of this point by Dr. J. Hopkinson has shown it to be 680deg. C., rising to 712deg. C. during recalcence. Dr. Hopkinson has also shown that the temperature at which steel ceases to be magnetic is 690deg. C., so that he has definitely established the important fact of the identity of the two temperatures.

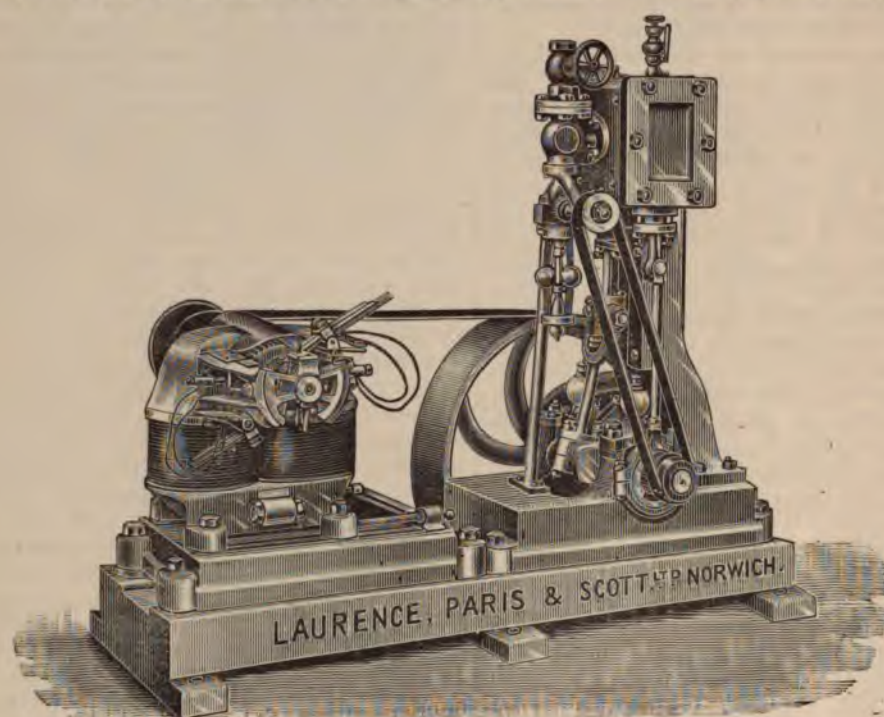
When we remember that the mechanical, electrical, and thermal properties of iron and steel are of the utmost

exists, which is intimately connected with the hardening or annealing of steel. They also draw attention to the numerous phenomena observed to occur at this temperature. Numerous other experimenters have worked at recalcence, notably Mr. Tomlinson, of King's College, and Mr. Newall, at Cambridge, but the bibliography and discussion of the whole subject will be reserved to the report next year.

BIRMINGHAM EXHIBITION.

We illustrate herewith a compact arrangement of engine and dynamo exhibited by Messrs. Laurence, Paris, and Scott, Limited, of Norwich.

This small plant has attracted considerable attention from visitors, as it is shown running full speed without steam connections. This caused one visitor to remark that he was "not aware that electricity could be made to act directly on a piston." The engine has a steel crankshaft with balanced crank, and the bearing surfaces are made amply large for the maximum pressure which they have to bear, whilst the lubricating arrangements are designed for continuous running. The governor is of the Pickering type, with facilities for adjusting the speed to which it is



practical importance, and that all these properties appear to undergo a remarkable change at the critical temperature, the need of a searching investigation on the question is obvious. Moreover, the interest is no less, from a theoretical point of view, in connection with theories as to the molecular structure of magnetised iron and steel.

Recalcence being feeble in soft iron, but marked in hard iron and in steel, it was conjectured that the phenomenon might be due to an action depending on the presence of carbon in iron, creating an effect analogous to that observed when water or super-saturated solutions are cooled below the solidifying point; a slight disturbance of the liquid thereupon producing a sort of explosive action, solidification occurring with a sudden rise of temperature. Prof. Roberts-Austen has drawn attention to the fact that lately M. Osmund, in France, has made recalcence the starting point of a new enquiry, tracing the effects of Carbon, Mn, Cr, S, P, and Si, on the points at which recalcence occurs or is destroyed by the alloy. That whilst pure iron does undergo a molecular change at a red heat, carbon retains its position as an important factor in determining the point of recalcence in hard iron and steel. Messrs. Barus and Strouhal have recently published in America a series of important papers on the tempering of steel, and shown that a critical temperature of between 500deg. and 1,000deg. C.

set without stopping the engine. The normal speed of the engine is slightly under 400 revolutions per minute; but it runs remarkably well at the latter, and even at higher speeds. The dimensions of the cylinder are 4½ in. bore, and 4½ in. stroke.

The dynamo is compound-wound and runs at 1,400 revolutions per minute. Its normal output is 25 amperes at 50 volts, or 1¼ kilowatts. It is driven by means of a very thin and flexible belt, 4½ in. wide, the dynamo pulley being 5 in. in diameter, with deep flanges. It is found that this arrangement works well in spite of the short distance between the engine-shaft and dynamo-spindle, whilst a sliding bedplate for the dynamo enables the belt to be tightened whilst running.

The same firm shows a number of motors driving the various machinery exhibits in all parts of the exhibition. These motors are shunt-wound and have also a special series winding of comparatively fine wire for temporary use in starting. This series winding serves the double purpose of strengthening the magnetic field and introducing resistance into the armature circuit until the starting is effected. When the armature is revolving at nearly full speed, a small detent is drawn aside by hand. This allows a starting switch, mounted on the pole-pieces and attracted by the field-magnets, to short-circuit the series winding by

means of a mercury contact. The motor is then self-regulating, running at practically constant speed with any load within its capacity.

When the current is switched off, the starting switch, being no longer attracted by the field-magnets, is raised by a helical spring, and locked by the detent ready for starting again. Thus, the difficulty in starting a shunt motor on a constant E.M.F. circuit is completely overcome without an external resistance frame with reducing switch, and the danger of switching on current to the motor without the starting resistance in the armature circuit is obviated by the automatic rising of the starting switch when the current is interrupted.

One of these motors is shown coupled direct to the spindle of an 18in. circular saw, and carried on a bracket fitted to the saw bench. This makes a compact and portable tool likely to be much used where current can be obtained to drive it.

Amongst this firm's other exhibits we may mention a centrifugal fan, driven by a small motor on the same bed-plate, the combination constituting a convenient bellows for a forge fire. We also notice over the doorway of one of the refreshment-rooms one of their small motors carrying a ventilating fan, and in the machinery hall a larger motor driving a large Blackman air-propeller. Also in the machinery hall a nine kilowatt dynamo driven by one of Messrs. Crossley's new type 9 h.p. gas-engines with tube-ignition, and a 12 kilowatt compound-wound dynamo driven by one of Messrs. Robey's new 10 h.p. compound high-speed steam-engines. These dynamos appear to be very compact, considering their output and speed, the 12 kilowatt running at only 725 revolutions per minute. We hope shortly to describe this firm's electricity-meter, which is said to record accurately through a very wide range.

THE MANUFACTURE OF THE ALLOYS OF ALUMINIUM IN THE ELECTRIC FURNACE.*

BY JOHN H. J. DAGGER, F.I.C., F.C.S.

Although aluminium is one of the most widely distributed of the elements, entering into the composition of nearly two hundred minerals, its oxide, alumina, was regarded as identical with lime until, in 1754, Margraff proved it to be a distinct substance.

In 1807, Davy, so successful with the oxides of the metals of the alkalies and alkaline earths, attempted to decompose alumina by the battery, but failed; and it was not until the year 1828 that Wöhler, by heating the chloride with metallic potassium, first obtained aluminium as a grey lustrous metallic powder, and, eighteen years later, in globules not larger than pinheads. From these, with extreme ingenuity, he determined the principal properties of the metal. In 1854, Deville, at that time Professor of Chemistry in the Ecole Normale, Paris, in course of some researches on the chloride, obtained a button of pure aluminium by the decomposition of the chloride with sodium; and on the 4th February in that year read a paper, describing his discovery, before the Academy of Science. As a result, a committee was formed to carry on experiments, 2,000*l.* being granted to meet expenses. On August 14th, he read a second paper before the Academy, exhibiting several bars of aluminium, and caused a medal of the metal to be struck and presented to the Emperor.

In March of the next year experiments on a large scale, at the Imperial cost, were instituted at Javel; and on June 18 Deville presented to the Academy, through M. Dumas, large bars of pure aluminium. These experiments are said to have cost the Emperor 35,000*l.* (£1,458).

Devil's method, modified in details, is still the chief of the chemical methods of preparing aluminium on a commercial scale, and is dependent on the cost of the metallic sodium and the double chloride of aluminium and sodium, which is the compound used in the most important of the present day processes.

Pure aluminium is a highly lustrous metal, white with a faint tinge of blue in colour. It resists the action of air

and moisture, even at high temperatures; is not blackened by exposure to the action of sulphuretted hydrogen or the alkaline sulphides; and is not attacked by fused nitre nitric, or dilute sulphuric acid. It dissolves readily in hydrochloric acid, or in solutions of the alkalies.

Its density is but two and one-half times that of water. Compared with other metals, its density is as follows:

Metal.	Density.	Compared with Aluminium.
Platinum	21.5	8.6
Gold	19.3	7.7
Lead	11.4	4.8
Silver	10.5	4.2
Copper	8.9	3.6
Iron	7.8	2.9
Tin	7.3	2.8
Zinc	7.1	2.8
Aluminium	2.5	1.0

In a paper read by Mr. W. H. Barlow before the British Association, 1882, its tenacity is given at 12 tons to the square inch; but weight for weight, it would equal high-class steel, or 36 tons per square inch. Its elasticity is almost equal to that of silver. Is ductile, can be drawn into very fine wire, and is almost as malleable as gold. Its thermal conductivity is about two-thirds that of copper. Its electrical is given by Deville as eight times that of iron. Its specific heat is .22; it melts at 1,300deg. F., but exhibits no tendency to volatilise, even though heated in a carbon crucible in a blast furnace to high temperatures.

The extreme lightness of aluminium, its power of resisting the action of air moisture and sulphuretted hydrogen, give it an advantage over silver, which it equals in tenacity and elasticity as a material for jewellery, and for scientific and astronomical instruments.

The greatest value of aluminium is as yet in its alloys, and it is with their production in the electric furnace I propose to deal to-day; and I may remark that the successful application of the intense heat of the electric arc to the production of metals on a commercial scale, marks a new departure in electro-metallurgy of which we cannot over estimate the importance, rendering it possible to produce rich alloys of aluminium at half the cost of any other process, and so widening the field of their application to an extent hitherto unknown.

Messrs. Cowles's first experiment was with a very refractory zinc ore, containing silver, which they had failed to reduce in an ordinary furnace. A fireclay tube was taken filled with a mixture of the crushed ore and charcoal powder, a bundle of electric light carbons inserted in each end, and a current from a small dynamo sent through the mass. In a short time the ore was reduced, but the fireclay tube was partly melted, showing the necessity for a lining that would protect the furnace walls from the intense heat. Powdered charcoal, a very feeble conductor of heat and electricity, was tried, but it was found that after a time it became converted into graphite, thus becoming a conductor; as the smelting proceeded changing gradually from the inside to the outside, and as the hot zone expanded causing loss of energy and eventually destroying the furnace. Mr. Alfred H. Cowles then suggested soaking the charcoal powder in milk of lime and drying before use. This proved successful, each particle of charcoal being coated with a film of lime, which insulates it, and prevents electrical conduction between neighbouring particles, even after the charcoal is converted into graphite. Messrs. Cowles now found that they had a furnace that would enable them to conduct metallurgical operations at a temperature hitherto unknown outside the laboratory, and after some experiments with corundum they, acting in conjunction with Prof. Mabery, set up the first plant for the production of aluminium bronze, ferro-aluminium, and silicon bronze, at the works of the Brush Electric Company, Cleveland, Ohio, U.S.A. On January 20, 1886, Mr. E. H. Cowles read a paper before the Franklin Institute, describing the electric furnace and a process of making aluminium bronze. The institute thought so highly of the importance of the discovery that they awarded to Messrs. Cowles the "Elliott" gold medal, the highest honour in the gift of the institute. The city of Philadelphia awarded them the "John Scott Legacy" medal, this being the only instance of the two awards falling to the same inventors.

* Paper read before the British Association at Newcastle-on-Tyne.

In 1887, Mr. E. H. Cowles was elected a Fellow of the Royal Society.

The results obtained at Cleveland were so satisfactory, though using only a dynamo of 300 amperes with E.M.F. of 60 volts, that in 1886 the Cowles Company commenced the works at Lockport, N.Y., U.S.A. The works at Lockport commenced operations with a Brush dynamo giving a current of 1,600 amperes with an E.M.F. of 45-50 volts, to this has been added two dynamos, each capable of supplying a current of 3,000 to 3,200 amperes, with an E.M.F. of 55 to 60 volts. A fourth dynamo is now building of 3,000 amperes. One striking feature of the Lockport works is the use of water power, the dynamos being actuated by two powerful turbines, 30in. diameter = 500 h.p.

The number of furnaces in operation are 14, producing about 300lb. of aluminum contained in alloys per 24 hours. Four additional furnaces are now building. I will now describe the English works of the company at Milton, Staffordshire.

These, the first electro-metallurgical works established in Europe, are situated near Milton Station, on the North Staffordshire Railway, with which system they are connected by a siding, and also about on a branch of the Trent and Mersey canal—thus affording facilities for cheap transit of raw material, coal, and finished products.

The experience at the Lockport works showed conclusively that great economies were to be expected from increasing the size of the furnaces and the strength of the electric currents; but no current of more than 3,000 amperes had been used up to the time the Milton works were planned.

Mr. Cowles then prepared a specification for a dynamo to give a current of 5,000 amperes at 60 volts, and eventually Messrs. Crompton's designs were accepted. This dynamo is of 500 h.p., and furnishes a current of 5,000 to 6,000 amperes, with an E.M.F. of 50 to 60 volts. It is said to be the largest machine (at least in regard to quantity of current) in England, and probably in the world. I will not describe this magnificent machine more fully, as it was the subject of a very interesting paper read by Mr. Crompton before the G section of the Association last year.

The boilers supplying steam to the works are of the Babcock-Wilcox type, representing 600 h.p., and are fitted with mechanical stokers; by this means one man can easily attend to the generation of steam for the whole works. The main engine, used for driving the dynamo only, is a compound condensing horizontal tandem engine, made by Messrs. Pollitt and Wigzell, of Sowerby Bridge, and is well worth noting for its beautiful workmanship. Its motion is, indeed, so silent, that, with your back to it at the moment of starting, you cannot tell whether it is in motion or not. It is of 600 h.p., and is provided with automatic expansion gear; and the centrifugal governor maintains the speed at 76 revolutions. It is needless to say that work of this kind involves rapid fluctuations of load, and as an additional precaution against racing, the engine is fitted with Tate's electrical stop-valve, which stops the engine automatically if the speed exceeds a certain limit. It can also be stopped from various points in the engine and furnace rooms by means of push buttons connected in parallel with the main circuit leading to the Tate valve.

The engine has a 23in. high-pressure and a 43in. low-pressure cylinder, the stroke is 5ft., the average steam pressure being 85lb. The flywheel is 20ft in diameter and weighs 20 tons, it is geared to the dynamo by 18 driving ropes, so that the dynamo makes five revolutions for each revolution of the engine.

From the dynamo the current is led by copper bars to an enormous "cut-out," calculated to fuse at 8,000 amperes. This is probably the largest ever designed, and consists of a framework carrying 12 lead plates, each 3½in. broad by 1½in. thick. From this it passes into the furnace-rooms; a current indicator is inserted in the circuit consisting of a solenoid of nine turns (this was cut out of a cylinder of cast copper by means of a parting tool, in a screw cutting lathe). In the solenoid is an iron core suspended by a spring; the movement of this is communicated to two pointers, one dial being placed in the engine-

room, the other in the furnace-room. The range of the indicator is such that the entire circle of 360deg. = 8,000 amperes.

There are two furnace-rooms, each containing six furnaces. The first room contains the bronze furnaces, in which is carried on the manufacture of aluminium copper and silicon copper. The second is devoted to the production of ferro-aluminium.

The furnaces are rectangular in form, built of firebrick, the internal dimensions being 60in. x 20in. x 36in. Into each end is built a cast-iron tube, through which the carbon electrodes enter the furnace. Each electrode consists of a bundle of nine carbons, each 2½in. diameter, attached to a head of cast iron, for ferro-aluminium, or cast copper when cupro-aluminium is made. Each carbon rod weighs 20lb.

Quite recently it has been possible to obtain carbons 3in. diameter, weighing 36lb.; these are employed in bundles of five.

The "head" of the electrode is secured to the copper rods or "leads," which can be readily connected with or disconnected from the flexible cables supplying the current.

Each cable is secured to slides running on omnibus bars of copper overhead, so that it can be brought into position opposite the furnace to be used.

The electrodes are arranged so that it is possible, by means of a handle and screw, to advance or withdraw them from each other in the furnace.

Lining the furnace is the first operation preparatory to smelting. This is done by covering the bottom of the trough with a layer of prepared charcoal.

Oak charcoal is used. This is ground under edge runners, treated with milk of lime and dried, first in a steam-jacketed revolving drum, and afterwards on a hot iron plate. Each particle of charcoal is thus coated with an insulating film of lime.

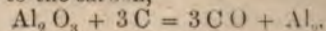
The electrodes are now arranged in the furnace, and a "former," consisting of two pieces of sheet iron connected by stirrups, arched so as to fit over the electrodes, forming a box without top or bottom (the size being dependent on the charge used), is dropped over the electrodes. Prepared charcoal is then rammed into the space between the iron sheet and the firebrick walls of the furnace. This done, the charge of ore, mixed with coarse charcoal and the metal to be alloyed with the aluminium, in form of turnings or granules, is placed inside the iron box, after which this is carefully withdrawn. Some broken pieces of carbon are arranged so as to connect the electrodes and start the current. The charge is then covered with coarse charcoal, and the cast-iron cover, having a hole in the centre for the escape of gases, is lifted into place, and luted so as to prevent the entrance of air.

The commencing current is about 3,000 amperes, gradually increasing to 5,000 amperes in the first half-hour. The time occupied by a "run" is about one and a-half hours. Soon after starting, the gases escaping from the orifice in the cover take fire and burn with a white flame; this gas consists mainly of carbonic oxide, with small quantities of the hydro-carbons and nitrogen. On the conclusion of the run the furnace is allowed to cool, the melted alloy collecting in the bottom of the furnace; the next furnace ready charged is connected, so that the process is a continuous one, the furnaces being successively charged and connected. A form of furnace in which the metal is tapped from the bottom, has given very satisfactory results.

The energy required to produce 1lb. of contained aluminium depends, of course, upon the grade of alloy; the average being 18 h.p. per hour.

The crude metal from the furnace is then refined and remelted in a reverberatory furnace; each "run" is sampled, and the percentage of aluminium ascertained by analysis.

The nature of the reaction that takes place in the electric furnace is not very easy to ascertain. The reduction of the ore takes place in an air-tight box, and in presence of an enormous excess of carbon. It may be assumed that at the intense heat of the electric arc the ore melts and gives up its oxygen to the carbon,



The presence of copper or iron is immaterial, as the reaction takes place with ore alone; but in absence of the alloying metal the liberated aluminium absorbs carbon, and is converted into a carbide.

Prof. Hampe, however, contends that the reaction is in two stages, the first being electrothermic, in which the ore melts; the second electrolytic, in which electrolysis of the molten oxide takes place, aluminium being liberated. Supposing an alternating current is used in the furnace instead of the continuous, and that we have a high number of alternations from recent experiments with alternating currents, we know that very slight, or no electrolytic action occurs; if, then, we get equal results, it would go to prove that the action is thermic and *not* electrolytic.

An experiment was made by the Cowles Company using an alternating current.

The furnace used was 48in. by 12in. by 24in. with current of 900 amperes with E.M.F. of 50 volts. Alternations per minute, 11,000.

At the end of 1½ hours we obtained 45lb. of 4 per cent. aluminium bronze.

This investigation was purely of an experimental character, and it cannot be doubted that on the larger commercial scale the result would be more satisfactory.

The results obtained were identical with those given by the continuous current in every way, the resultant slags similar in composition.

The slag from the electric furnace is really only melted unreduced ore, and not a slag in the proper sense of the word. Its approximate composition is $\text{Al}_2\text{O}_3 - 90$ $\text{SiO}_2 - 2.00$ $\text{Fe}_2\text{O}_3 - 4.00$ $\text{CaO} - 3.9$ $\text{P} - 0.10$.

The charcoal from the old linings which has been partially converted into graphite, is recrushed and treated with milk of lime, dried as before, and thus used many times over. The crude metal from the "runs" is remelted with fluor spar as a flux, and tapped from the reverberatory furnace into ingots or plates. The refinery slag is put into a revolving drum for breaking into pieces, and then washed to remove carbon. The entangled particles of alloy are thus recovered and are worked up with other charges. These operations are carried out in a separate building—the "reclaiming-house."

These works produce about 200lb. of contained aluminium per 24 hours; the most valuable alloy being aluminium bronze, which is supplied in grades containing 1½ to 11 per cent. aluminium. To obtain these the rich furnace product, containing 15 to 20 per cent. aluminium, is remelted and reduced to the desired percentage with metallic copper, and cast in 12lb. ingots.

(To be continued.)

THE OLD STUDENTS' DINNER.

The fifth annual dinner of the City and Guilds of London Institute Old Students' Association took place on Saturday at the Manchester Hotel, Aldersgate, Mr. Thomas Adams, president, in the chair. The meeting, owing to the shortness of the notice, was not perhaps quite so well attended as last year, but nevertheless a very good muster was made, among whom were the well-known faces of many of those who are active in electrical enterprise in London. Mr. Sebastian was the guest of the evening on behalf of the City companies, and Profs. Silvanus Thompson, W. C. Unwin, John Perry, R. Meldola, of the Finsbury and Kensington technical colleges, met once more to pass a social evening with their old pupils. Dr. W. E. Sumpner (who has lately received the degree of D.Sc. at the London University) was president-elect for the ensuing year.

The Chairman (Mr. Adams) first proposed the usual toast of "The Queen."

Mr. H. Newman Lawrence proposed "The Colleges of the City and Guilds of London Institute," coupled with the names of Profs. W. C. Unwin and Silvanus P. Thompson. Mr. Lawrence alluded to the constantly growing importance of the past students of the colleges. Many, he mentioned, were now holding important and re-

sponsible positions in all quarters of the globe; some were managers of works, chemical and electrical, in London or parts of England; one was now professor in the Technical College of Madras; some were engaged in continental or colonial work; and others were just about to depart to undertake important work in Brazil and in Mexico, so that it would be seen the influence of the colleges was spreading over the whole world. He would like to say with reference to the recent Arts and Crafts Exhibition that it appeared that in such a direction as this the technical colleges ought to take part.

Prof. Unwin, responding for the Central Institution, South Kensington, said it had been a little thought in some quarters that the students at the Central were like the inhabitants in a story he had heard of a fence and graveyard: "The fellows outside didn't want to come in, and the fellows inside couldn't get out." But he thought if they had seen the trouble they have had to arrange their timetable, to take in all the students applying, they would perceive the activity of the Central Institution. As to there being not sufficient outlet for these highly-finished men when trained, he would remind them that the same thought had been mooted when mechanical engineering students were raised, but the 600 public appointments of the Indian Department was only one of many outlets for trained men which were filled from these sources. To illustrate the usefulness of the Central training, Prof. Unwin alluded to one student who, after six months in a large factory, had his qualities so appreciated that he had been appointed assistant manager of works. Another case of the advantage of real technical training was that of one student who had received an appointment at the Brush Company, where he had to design shafting, and arrange and superintend the laying out of installations. Recently he had been sent to Holland, and, with only two visits from his chief, had designed, superintended the building, laid out foundations, and got the machinery into position successfully, with only the assistance of Dutch workmen. One way in which the training had come in most useful had been when he had to design a 200ft. roof of a new type, and marked out the joints for the workmen to work to.

Prof. Silvanus P. Thompson, responding for Finsbury College, said the day for apologising for the usefulness of these technical colleges had, he was glad to say, now gone by. The members of the City guilds had begun to feel that they had been doing a really profitable and useful task, one which put a crowning point on the works of the City guilds. The usefulness of the college was still restricted for want of sufficient accommodation and resources to meet with the increase of students, but prospects were certainly more hopeful than they were a year ago. The timber yard site, next the college, was their ambition to add to the accommodation. They had, it would be remembered, hoped to obtain this site, but on the point of settlement these hopes had been cruelly dashed. Well, the site was still vacant, and not only so, but he had just learnt that the whole row of cottages, with the sugar factory beyond, and the shop and a shed behind that—these are all to be had on a 99 years lease for £12,000. What, asked Dr. Thompson, is £12,000, if we consider the future of English youth, when we see £50,000 or even £100,000 given for institutes in all parts of London. With regard to expenditure it was understood that there would have been £800 less to spend last year, and it was feared that some one of the departments would have to be sacrificed. They could not sacrifice the electrical, the chemical, or the mechanical sections—they might the trades or the arts section. But just as they had almost resolved upon the loss of the arts he had thought of a scheme to save it. He remembered that the Corporation, on taking over the premises, had imposed the carrying on of the art classes, costing some £2,000 a year. He resolved, therefore, to represent the matter in the right quarter, and he had received help to the extent of £1,000. Not only so, but the Merchant Taylors' Company, who had hitherto held aloof (except for a £50 note at the commencement), suddenly subscribed £2,000 to Finsbury, so that they were now really in a much better position. They had extended the electric lighting, improved the heating and ventilation, and made other improvements. They

were still, however, greatly cramped for room, and the rush at the opening of this session was terrific, and they were seriously thinking of opening the laboratories on other nights, although the professors and assistants were already overworked. It was a great pleasure to him to see that one of the pupils, the president-elect, had taken the highest honour the University of London could accord, and another, Dr. Moody, had also done the same last year, for although the bulk of the work of the college was in training for other work than examinations or degrees, these were certainly advantageous when they could be taken as a side issue. Prof. Thompson also mentioned that when in Paris he had had the pleasure of meeting Mr. Edison, who, although he was not, perhaps, the greatest electrician in the world, was by a great many persons usually supposed to be so. He had given some particulars of the great laboratory at Orange, where he, Mr. Edison, had a library of more books than both the colleges, a steam-engine of equal power to both their own rolled into one, and more electric light than Profs. Ayrton and Perry could muster. Now over this fine laboratory Mr. Edison's chief of works is an old City Guilds scholar, Mr. Kennelly—one who was under Prof. Ayrton at Finsbury—and Edison said, "Whenever I want to know anything about electricity, I just ask Kennelly. I could do with another of the same sort." And Prof. Thompson said he had promised to send him another.

The medal of the association was then announced as to be given to Mr. Heller for his paper, that of Mr. Appleton having run it almost a tie. Mr. Albion T. Snell's paper had been withdrawn from competition.

The names of the officers were announced: President, Dr. W. E. Sumpner; hon. secretaries, Messrs. F. Maunce Smith and Le Tall; vice-presidents, Messrs. Rance and Slater; committee, Messrs. Bourne, Lamb, R. J. Jones, Hume, Miss Walter, Messrs. Beck, Haes, and Crompton.

Prof. Perry, proposing the toast of "The Old Students' Association," alluded to the usefulness of the association as a club, holding together the members, keeping the professors always in touch with their past pupils. He had not, he was sorry to say, attended many of their meetings for papers, but he had attended all the smoking parties and the river parties, and hailed such meetings as very useful in fusing the members of a profession together. The papers, though he had not heard them, he had read them, and he could say sincerely that such papers as that of Mr. Albion Snell would do credit to the members of the oldest engineering associations.

Dr. Sumpner, in replying, bore witness to the successful efforts of Mr. Pettigrew and Mr. Adams, who had rendered the association now practically an assured success. He said it had been felt that more meetings of a social nature best promoted the objects of the association, and during his presidency he would do all he could to secure its continued and extended success. It would be easier, he said, if more would join, for with 400 members the expenses would not be often much more than for 200, and the margin would be much greater. He mentioned that arrangements had been made to continue the *Journal* as efficiently as possible, and to supply it at half price to members. He looked for help in his year's work to the whole of the members.

Mr. Esson then proposed "The Visitors," coupling with it the name of Mr. Sebastian, and said, with some humour, that he had little doubt but that the visitors considered them a very jolly set of fellows, but he could assure them that if they would look in when a heavy paper was on these visitors would find they were also very learned.

Mr. Sebastian, replying, said he came as a representative of the City guilds, and was extremely pleased to see the influence these colleges seemed to be having in far-reaching ways. His own knowledge of electricity was confined to an experiment, many years ago, with little grey globules known, he thought, as "pith balls"—he was glad to see the allusion was appreciated by the technical audience—something to do with attraction and repulsion, and repulsion had, with him, got the upper hand. However, it wanted no science to see the influence of the colleges was beginning to be apparent, and it was very gratifying to see the great success of the Old Students. He likened himself,

as a member of the Guilds Institute Committee, to a common force pump—the supplier of crude material to be turned into power, and he would promise to use his pumping powers as far as possible in such a nationally useful work.

The meeting terminated with speeches in honour of and by Mr. T. Adams (past-president), who is going on a prospecting tour to Mexico, and Mr. Crombie, who is going to Brazil as president of a technical college.

ADDRESS TO THE MECHANICAL SCIENCE SECTION OF THE BRITISH ASSOCIATION.

BY WILLIAM ANDERSON, M.I.C.E., PRESIDENT OF THE SECTION.

(Continued from page 294).

One of the most remarkable features of the last thirty years is the introduction of petroleum, and the wonderful development to which the trade in it has attained.

Under the generic name of petroleum are embraced a vast variety of combinations of carbon and hydrogen, each of which is distinguished by some special property. At ordinary temperatures and pressures some are gaseous, some are liquid, and some solid, and most are capable of being modified by suitable treatment under various temperatures and pressures. The employment of petroleum in the arts is still extending rapidly. Used originally for illuminating purposes, it is now employed as fuel for heating furnaces and steam-boilers; as a working agent in heat-engines, valuable medicinal properties have been discovered; and as a lubricant it stands unrivalled.

As an illuminant, even in this country, it is, to a large extent, superseding every other in private houses, and even in public lamps, because it gives a cheaper and more brilliant light than ordinary gas, and leaves the consumer free from the tyranny of great and privileged companies.

As fuel it is especially convenient, cleanly, and economical. Stored in tanks of suitable construction, it is sprayed into the furnace without labour and without creating dust and dirt; and it is especially convenient in locomotive and marine work on account of the rapidity, ease, and cleanliness with which it can be run into the tender or into the oil-bunkers of a ship. As a working agent in heat-engines it is employed in two ways. First as a vapour, generated from the liquid petroleum contained in a boiler, very much in the same way as the vapour of water is used in an engine with surface condenser, the fuel for producing the vapour being also petroleum. Very signal success has been obtained by Mr. Yarrow and others in this mode of using mineral oil, especially for marine purposes and for engines of small power; there seems to be no doubt that by using a highly volatile spirit in the boiler a given amount of fuel will produce double the power obtainable by other means, and at the same time the machinery will be lighter and will occupy less space than if steam were the agent used. The other method is to inject a very fine spray of hot oil, associated with the proper quantity of air, into the cylinder of an ordinary gas-engine, and ignite it there by means of an electric spark or other suitable means. Attempts to use oil in this way date back many years, but it was not till 1888 that Messrs. Priestman Brothers exhibited at the Nottingham Show of the Royal Agricultural Society an engine which worked successfully with oil, the flashing point of which was higher than 75deg. F., and was therefore within the category of safe oils. The engine exhibited was very like an ordinary Otto gas-engine, and worked in exactly the same cycle. A pump at the side of the engine forced air into a small receiver at a few pounds' pressure to the square inch. The compressed air acting by means of a small injector, carried with it the oil in the form of fine spray, which issued into a jacketed chamber heated by the exhaust, in which the oil was vapourised. The mingled air and oil was thus raised to a temperature of about 300deg., and was then drawn, with more air, into the cylinder, where, after being compressed by the return stroke of the piston, it was exploded by an electric spark, and at the end of the cycle the products of combustion were discharged into the air after encircling the spray chamber and parting with most of their heat to the injected oil. The results of careful experiments made by Sir William Thomson and by myself on different occasions were that 1·73lb. of petroleum were consumed per brake horse-power per hour; but the combustion was by no means perfect, for a sheet of paper held over the exhaust-pipe was soon thickly bespattered with spots of oil.

At the Windsor Show of the Royal Agricultural Society this year Messrs. Priestman again exhibited improved forms of their engine; the consumption of oil fell to 1·25lb. per brake horse-power per hour, and a sheet of paper held over the exhaust remained perfectly clean. They also showed a portable engine of very compact construction, and quite adapted to agricultural use; the ordinary water-cart, which has, in any case, to attend

a portable steam-engine, being adapted to supply the water necessary to keep the working cylinder of the engine cool.

It is hardly necessary to state that the use of petroleum for furnace purposes of all kinds is increasing very rapidly, and the demand has naturally reacted on the supply in promoting improved means of transport; and Newcastle, again, has led the van in this matter, for Sir William Armstrong, Mitchell, and Co. have sent out a fleet of steamers constructed to carry the oil in bulk with perfect safety, both as regards the stowage of a cargo so eminently shifting, and with respect to risk from fire and from explosion.

The enormous consumption of petroleum and of natural gases frequently raises the question as to the probability of the proximate exhaustion of the supply; and, without doubt, many fear to adopt the use of oil from a feeling that if such use once becomes general, the demand will exceed the production, the price will rise indefinitely, and old methods of illumination and old forms of fuel will have to be reverted to. From this point of view it is most interesting to enquire what are the probabilities of a continuous supply, and such an investigation leads at once to the question, "What is the origin of petroleum?" In the year 1877 Prof. Mendeleeff undertook to answer this question, and as his theory appears to be very little known, and has never been fully set forth in the English language, I trust you will forgive me for laying a matter so interesting before you. Dr. Mendeleeff commences his essay by the statement that most persons assume, without any special reason, excepting, perhaps, its chemical composition, that naphtha, like coal, has a vegetable origin. He combats this hypothesis, and points out, in the first place, that naphtha must have been formed in the depths of the earth. It could not have been produced on the surface, because it would have evaporated; nor over a sea bottom, because it would have floated up and been dissipated by the same means. In the next place he shows that naphtha must have been formed beneath the very site on which it is found—that it cannot have come from a distance, like so many other geological deposits, and for the reasons given above—namely, that it could not be water-borne, and could not have flowed along the surface, while in the superficial sands in which it is generally found no one has ever discovered the presence of organised matter in sufficiently large masses to have served as a source for the enormous quantity of oil and gas yielded in some districts; and hence it is most probable that it has risen from much greater depths under the influence of its own gaseous pressure, or floated up upon the surface of water, with which it is so frequently associated.

The oil-bearing strata in Europe belong chiefly to the Tertiary or later geological epochs; so that it is conceivable that in these strata, or in those immediately below them, carboniferous deposits may exist and may be the sources of the oil; but in America and in Canada the oil-bearing sands are found in the Devonian and Silurian formations, which are either destitute of organic remains or contain them in insignificant quantities. Yet if the immense masses of hydrocarbons have been produced by chemical changes in carboniferous beds, equally large masses of solid carboniferous remains must still exist; but of this there is absolutely no evidence, while cases occur in Pennsylvania where oil is obtained from the Devonian rocks underlying compact clay beds, on which rest coal-bearing strata. Had the oil been derived from the coal, it certainly would not have made its way downwards; much less would it have penetrated an impermeable stratum of clay. The conclusion arrived at is, that it is impossible to ascribe the formation of naphtha to chemical changes produced by heat and pressure in ancient organised remains.

One of the first indices to the solution of the question lies in the situation of the oil-bearing regions. They always occur in the neighbourhood of, and run parallel to, mountain ranges, as, for example, in Pennsylvania, along the Alleghenies; in Russia, along the Caucasus. The crests of the ranges, formed originally of horizontal strata which had been forced up by internal pressure, must have been cracked and dislocated, the fissures widening outwards, while similar cracks must have been formed at the bases of the ranges; but the fissures would widen downwards, and would form channels and cavities into which naphtha, formed in the depths to which the fissures descended, would rise and manifest itself, especially in localities where the surface had been sufficiently lowered by denudation or otherwise.

It is in the lowest depths of these fissures that we must seek the laboratories in which the oil is formed; and, once produced, it must inevitably rise to the surface, whether forced up by its own pent-up gases or vapours, or floated up by associated water. In some instances the oil, penetrating or soaking through the surface layers, loses its more volatile constituents by evaporation, and, in consequence, deposits of pitch, of carboniferous shales, and asphalt take place. In other cases the oil, impregnating sands at a lower level, is often found under great pressure, and associated with forms of itself in a permanently gaseous state. This oil may be distributed widely, according to the nature of the formations or the disturbances to which they have been subjected; but the presence of petroleum is not in any way connected with the geological age of the oil-bearing strata. It is

simply the result of physical condition and of surface structure. According to the views of Laplace, the planetary system has been formed from incandescent matter torn from the solar equatorial regions. In the first instance this matter formed a ring analogous to those which we now see surrounding Saturn, and consisted of all kinds of substances at a high temperature, and from this mass a sphere of vapours, of larger diameter than the earth now has, was gradually separated. The various vapours and gases which, diffused through each other, formed at first an atmosphere round an imaginary centre, gradually assumed the form of a liquid globe and exerted pressures incomparably higher than those which we experience now at the base of our present atmosphere. According to Dalton's laws, gases, when diffused through each other, behave as if they were separate; hence the lighter gases would preponderate in the outer regions of the vaporous globe, while the heavier ones would accumulate to a larger extent at the central portion, and at the same time the gases circulating from the centre to the circumference would expand, perform work, would cool in consequence, and at some period would assume the liquid or even the solid state, just as we find the vapour of water diffused through our present atmosphere does now. That which is true of changes of physical condition, Henri St. Claire Deville, in his brilliant theory of dissociation, has shown to be equally true with respect to chemical changes; and the cooling of the vapours forming the earth while in its gaseous condition was necessarily accompanied by chemical combinations, which took place chiefly on the outer surface, where oxides of the metals were formed; and as these are generally less volatile than the metals themselves, they were precipitated on to what there then was of liquid or solid of the earth, in the form of metallic rain or snow, and were again probably decomposed, in part at least, to their vaporous condition. The necessary consequence of this action is that the inner regions of the earth must consist of substances the vapours of which have high specific densities and high molecular weights—that is to say, composed of elements having high atomic weights—and that the heavier elementary substances would collect nearer the centre, while the lighter ones would be found nearer the surface. Our knowledge of the earth's crust extends but to an insignificant distance; yet, as far as we do know it, we find that the arrangement above indicated prevails. Hydrogen, carbon, nitrogen, oxygen, sodium, magnesium, aluminium, silicon, phosphorus, sulphur, chlorine, potassium, calcium, substances whose atomic weights range from 1 to 40, became condensed, entered into every conceivable combination with each other, and produced substances the specific gravity of which averages about $2\frac{1}{2}$, never exceeds 4, and are found near the immediate surface of the globe.

(To be continued.)

COMPANIES' MEETINGS.

ANGLO-AMERICAN BRUSH COMPANY.

A meeting of shareholders in the Anglo-American Brush Electric Light Corporation, Limited (in liquidation), was held on the 10th inst. at the offices, Belvedere-road, S.E., Mr. E. Gareke, one of the liquidators, presiding.

The Chairman stated that the business of the meeting was purely formal, it having been called to settle the list of shareholders who were contributories, and to enable the certificates of the new company—the Brush Electrical Engineering Company, Limited—to be prepared and issued. He might take that opportunity of stating that the business of the new company was proceeding very satisfactorily. They were extremely busy with current orders, and the arrangements had been completed for taking over the new works at Loughborough of the Falcon Company, which were fully occupied at present with orders from the new company. He should be happy to answer any questions, but unless any objections were raised by the shareholders the list of contributories which he had prepared would be settled, and the certificates of the new company would be made out accordingly. The shareholders had all had notice of their holdings as settled in the list referred to. In reply to Mr. William Ash, the chairman stated that the nominal value of the old shares was £5. One preference share of £2 and one ordinary share of £3 in the new company would be given in exchange for every old share. There being no other questions, the Chairman stated that the list would be settled as he had prepared it.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts of this Company for the week ended October 11 amounted to £3,793.

Electricity Supply Company.—The allotment letters to applicants for shares in the Electric Supply Company for Spain, Limited, have been posted.

Western and Brazilian Telegraph Company, Limited.—The receipts for the week ended October 11, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,749.

Direct United States Cable Company, Limited.—This Company have declared an interim dividend of 3s. 6d. per share, tax free, being at the rate of 3½ per cent. per annum, for the quarter ending September 30, payable on the 24th inst.

Western Union Telegraph Company.—The English Association of American Bond and Shareholders, Limited, notify that they are prepared to pay, on and after the 15th inst., coupon No. 5 on their certificates against the shares of the Western Union Telegraph Company for the quarterly dividend of 1½ per cent.

Anglo-American Telegraph Company, Limited.—This Company have declared an interim dividend for the quarter ending September 30 of 12s. 6d. per cent. on the ordinary, and 25s. per cent. on the preferred stocks, less income tax, payable on November 1 to the stockholders registered on the books on October 7.

Eastern Extension, &c., Company, Limited.—The traffic receipts of this Company for the half-year ended June 30 states that the gross receipts, including Government subsidies, amounted to £256,757, against £239,926, the working and other expenses, including £22,626 for cost of repairs to cables and expenses of ships, absorbing £73,773, against £69,297. The net profit was £138,736, against £125,804. Against that amount the Directors have charged £50,000 on account of the Western Australian cable. One quarterly interim dividend of 1½ per cent., amounting to £31,250, was paid during the half-year, and another of like amount will be distributed on the 15th inst., leaving £26,236 to be carried forward. During the half-year the Saigon end of the Saigon-Hongkong cable was partially renewed, and the cost of the operation, amounting to £8,092, charged against the reserve fund. Since June 30 a further length of 127 nautical miles has been renewed, leaving only about 14 miles to complete the renewal of the shallow water portion off Saigon. This, together with the renewal of the shallow water portion of the Hongkong end of the cable, will shortly be carried out.

Monte Video Telephone Company.—The report of the Directors, to be presented to the shareholders at the annual general meeting to be held to-day, states that the first annual statement of accounts, made up to July 31 last, shows a profit of £10,439. 15s. 10d. Off this sum there has been written £114. 14s. 5d. for preliminary expenses, and £22. 2s. 9d. for depreciation of furniture, leaving a balance of £10,302. 18s. 8d. The Directors recommend that of this amount the full dividend of 6 per cent. be paid on the preference shares, which absorbs £7,290, leaving a balance of £3,012. 18s. 6d., which is applicable to a dividend on the ordinary shares. They further recommend that a dividend of 2½ per cent. be paid on the ordinary shares, that £1,000 be placed to renewal fund, and that the balance of £325. 8s. 5d. be carried forward. An interim dividend on the preference shares was paid in March last. As already notified to the shareholders, it was deemed expedient to purchase in December last the business of the Monte Video branch of the River Plate Telephone and Electric Light Company, Limited, and thus consolidate the telephone interests in that city. During the year the sum of £9,646. 18s. 9d. has been expended on capital account in consequence of the amalgamation of the telephonic interests now under the control of the Company, and in providing the requisite plant for the most efficient telephonic service possible, such as the multiple switchboard, aerial cables, etc. In order to meet this exceptional expenditure, the Directors have arranged for the issue of a portion of the unallotted capital of the Company under the powers conferred upon them.

NEW COMPANIES REGISTERED.

Electric Arms and Ammunition Syndicate, Limited.—Registered by Ashurst, Morris, Crisp, and Co., 6, Old Jewry, E.C., with a capital of £40,000 in £100 shares. Object: to enter into an agreement with the American Electric Arms and Ammunition Company to purchase certain patents and inventions; to use, develop, grant licenses in respect of, or turn to account the same, and to carry on any business which may be deemed directly or indirectly to benefit the Company. The first subscribers are:

	Shares
Major C. B. Waller, Clarence Lodge, Clapham Park	1
C. A. Pierce, 27, Throgmorton-street, E.C.	1
Colonel E. Villiers, 5, Brechin-place, Gloucester-road, S.W.	1
J. Pender, Thornby Hall, Northamptonshire	1
Captain J. Balfour, Buscot House, Oxon.	1
Major J. J. Wright, 16, Carlisle-mansions, S.W.	1
T. Gemmell, 45, Gloucester-street, Warwick-square, S.W.	1

There shall not be less than three nor more than seven Directors. The first to be appointed by the subscribers to the memorandum of association. Remuneration, £100 each.

PROVISIONAL PATENTS, 1889.

OCTOBER 7.

15700. **Improvements in dynamo machines for electro plating.** William Brooks Sayers, 24, Glycena-road, Lavender Hill, London.
 15721. **Improvements in electric motors.** Henry Groswith, 70, Wellington-street, Glasgow. (Complete specification.)
 15733. **Improvements in electrical signalling apparatus.** Eugene Dueretel, 45, Southampton-buildings, London.

OCTOBER 8.

15769. **Apparatus for measuring and recording electric currents.** Sir William Thomson, 154, St. Vincent-street, Glasgow.
 15775. **Improvements in electro-dynamic and dynamo-electric machines.** Charles F. Winkler, 70, Market-street, Manchester. (Complete specification.)
 15819. **Improvements in devices for connecting the plates of one electric battery with another battery or batteries, and with a switch-board or transmitting device.** Walter Francis Smith, 323, High Holborn, London. (Complete specification.)
 15820. **Improvements in frames for supporting the plates or elements of a secondary or storage battery.** Walter Francis Smith, 323, High Holborn, London. (Complete specification.)
 15821. **Improvements in the method of electro-lytically reducing plates of metallic salts to a metal state to "form" the electrodes of secondary or storage batteries.** Stanley Charles Outhbert Currie, 323, High Holborn, London. (Complete specification.)

OCTOBER 9.

15840. **A new and improved meter for electric and other purposes, and for the differential actuating movement thereof.** Francis Henry Nalder, Herbert Nalder, Charles William Scott Crawley, and Alfred Soames, 132, Horseferry-road, Westminster.
 15848. **Improvements connected with kerbings of pavements as means or apparatus for containing electric and like wires, gas, water, or other pipes or the like.** James Alfred Shelton, 166, Fleet-street, London.

OCTOBER 10.

15936. **Methods and apparatus for cleaning electric lamps.** James Robson, 32, Queenshead-lane, Handsworth, Staffordshire.
 15958. **A method of and appliances for preventing excessive heating or undue expansion of electric mains or service conductors through excess of electricity, and, if convenient, utilising such excess.** Francis William Engelbach and Edward Brailsford Bright, 4, Adelaide-street, Strand.
 15963. **Improvements in the manufacture of electrodes or plates for electrical purposes.** Paul Schoop, 46, Lincoln's-inn-fields, London.
 15967. **Improvements in insulating supports for overhead electrical conductors.** Walter Claude Johnson and Samuel Edmund Phillips, 28, Southampton-buildings, London.
 15968. **Improvements in insulating supports for underground electrical conductors.** Walter Claude Johnson and Samuel Edmund Phillips, 28, Southampton-buildings, London.

OCTOBER 11.

16036. **Improvements in galvanic batteries.** William Edwin Irish, 18, Buckingham-street, London. (Complete specification.)

OCTOBER 12.

16052. **A new or improved electric safety device.** Christopher Cummings, 9, Westland-road, Dublin.
 16084. **Improvements in electricity meters.** Ernest de Pass, 68, Fleet-street, London. (Etienne Marés, France.)

SPECIFICATIONS PUBLISHED.

1887.

7530. **Electrical transformers.** Statter. (Reprints, with alterations.) (Complete specification.) 8d.

1888.

13622. **Electric meters.** De Ferranti. 8d.
 16257. **Arc lamps.** Brown. 8d.
 16625. **Electric arc lamps.** Anderson. 8d.
 16954. **Electro-plated goods.** Oetzmann. 4d.

1889.

12437. **Electric drinking vessels.** Flint. 6d.
 12752. **Secondary battery plates.** Morris and Salom. 8d.
 13135. **Coin-controlled telephone.** Lake (Gray and Sovy). 6d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.	Name	Paid.	Price Wednesday
12 Feb. 1/2	Anglo-American Brush E.L.	—	4½
12 Feb. 2/0	— fully paid	—	5½
14 Nov. 0/4½	Con Telephone & Main ...	1	3
27 July 10/0	India Rubber, G. P. & Tel.	10	19½
.....	House-to-House	4½	5
.....	Metropn Electric Supply	—	3½
.....	London Electric Supply ..	5	4½
.....	Swan United	3½	5½
12 July 12/0	Telegraph Construction ...	12	43½
2 July 6/0	— 8½, 1889	100	105
.....	National Telephone	5	6½

NOTES.

Victor Turbine.—The Académie Nationale of France have just awarded Mr. Frederic Nell their gold medal of the first class for the "Victor" turbine.

Newry.—Has any electric firm or company given attention to Newry? It might be worth while, as loud complaints are being made of the bad quality of the gas.

Patents.—A neat little instruction book on patents, registration, copyright, etc., has been sent to us by Mr. William Jordan, Central Patent Offices, 120, Chancery-lane.

Overhead Wires.—The Post Office seems to have been dropped upon this time with reference to overhead wires, the Wandsworth District Board declining unanimously to sanction the erection of proposed overhead wires for additional fire alarms.

Overhead and Storage Competing.—The tramway line at Savannah, Galveston, is contemplating running its cars by electricity, either on the overhead wire or the storage battery system. The Daft and Sprague companies have submitted propositions.

Bournemouth.—The Lighting Committee has been called together for the purpose of meeting the manager of the Electric Light Company and paying a visit to the works at Bourne Valley, in order to see the arrangements for the lighting of the town.

Indian Telegraph Department.—It seems now pretty certain, says the *Indian Engineer*, that Mr. W. R. Brooke, Officiating Deputy Director-General of Telegraphs in India, will succeed Colonel Mallock when the latter retires from the Director-Generalship.

Personal.—Mr. A. A. Campbell Swinton is now Messrs. C. A. Parsons and Co.'s London representative for the supply of all their manufactures. Messrs. Parsons will remove into their extensive new works at Heaton, Newcastle-on-Tyne, on the 10th November.

Sale by Auction.—Messrs. Beal, Son, and Chartres will offer for sale on Friday, the 1st November, the whole of the electrical and mechanical plant which belonged to the late Sir Charles Bright, deceased. Full particulars will be found in our advertisement columns.

Leamington Pump Room.—At the monthly meeting of the Leamington Town Council it was decided that the new swimming-bath at the pump-room should be lighted with electricity, and the committee were instructed to at once accept a tender for carrying out the work.

Rochester.—The Rochester Town Council have decided to adopt electric lighting for the municipal buildings. The Vines Congregational Church will, in future, be illuminated with the electric light. This is stated to be the first place of public worship in the county to adopt the light.

Glasgow.—At the meeting of the Glasgow Town Council on Oct. 17, the town clerk reported that it would be necessary to apply to Parliament during next session for additional powers (1) to protect the banks of the Clyde; (2) to extend the boundaries of the city; and (3) to supply electric light.

Barnet.—It is a long lane that has no turning. We understand that the Heisler plant, of 250 light capacity, has reached Barnet and is ready for fixing. It is hoped that the introduction of this system will put an end to the

lengthy discussions which are taking place at Barnet over the electric light.

Electric Train Controller.—We have received a leaflet from Mr. Henry James Peddie, of Tynecastle Iron Works, Gorgie-road, Edinburgh, who wishes to make arrangements to introduce practically the ingenious railway electric controller and electric detector system noticed by us on July 19, 1889.

Lichterfeld Electric Railway.—The Municipality of Lichterfeld, near Berlin, have granted to Messrs. Siemens and Halske permission to extend the electric railway which now runs from the Anhalt railway station at Berlin to the military school at Lichterfeld. The line will be continued to the railway station at Potsdam.

Telephoning.—The longest distance over which conversation by telephone is daily made is between Portland, Me., and Buffalo, N.Y., about 750 miles. There are more than 170,000 miles of telephone wire in operation in the United States, over which 1,055,000 messages are sent daily. About 300,000 telephones are in use in the United States.

Electric Boat.—An electric boat has been running this month in America on the Housatonic river. It is 14ft. in length and 4ft. wide. There are 50 storage cells for supply of power. The boat is furnished with a Perret motor of 1 h.p. at 100 volts, especially constructed that on starting the power is applied gradually, thus obviating the danger of burning out the armature. The boat has proved a great success.

Barnsley.—A meeting of the Council is to be held on Friday, Nov. 22, to consider the expediency of adopting the following resolution: "That application be made to the Board of Trade for a provisional order authorising the Mayor, aldermen, and burgesses of the borough of Barnsley, in the county of York, to erect and maintain electric works and lines for supplying electricity within the said borough.

Electric Traction.—We understand that at length one of the firms which has been so successful in America, is about to push its business in England. We refer to the Thomson-Houston Co., and we have no doubt that when this company has shown us that there is plenty of work to be done in England, some of the English companies will awaken to the fact that the market which has been so long in their hands is lost to them.

Telephones in Germany.—According to the *Centralblatt für Elektrotechnik*, the telephone lines in Germany, at the end of last year, amounted to 10,607 kilometres. The longest line is that between Berlin and Breslau, of which the length is 348 kilometres. The line most largely used is that between Hamburg and Lubeck, which shows a daily average of 390 messages; it is followed by the line between Bremen and Bremerhaven with 276 messages daily. The average daily number of messages on the whole system is 28,099.

Dundee.—At a joint meeting of the Dundee Electric Lighting Committees of the Town Council and Police Commission which has been held, the opinion was expressed that the representative basis of the Gas Commission, which consists at present to a large extent of members from the Guildry and the Chamber of Commerce, should be greatly enlarged, and that they should apply to Parliament for power to accomplish this object, along with power to manufacture electric light. It was agreed to meet the Gas Commissioners on the subject, and to report,

Incandescent Lampholders.—We hear on the best authority that the claims of the early patents for incandescent lampholders for the attachment of an incandescent lamp to a holder by contacts or springs, are intended to be enforced. We are informed that one of the largest firms of electrical manufacturers and suppliers have investigated these claims and acknowledged them, and are now paying royalty upon all incandescent lampholders. This, it can be seen, is a very far-reaching move. It is rumoured that the Vitrite Company in consequence of this action intend to remove their manufactory to the continent.

Will the Gas Companies Move?—Our contemporary who devotes itself to both gas and electricity asks: "Instead of depreciating the electric light, why does not Mr. George Livesey use his influence amongst directors of gas companies and others to frame a scheme to lay before Parliament, by which powers to generate electricity and supply current for light and power, may be secured to gas suppliers?" Some of the securities in gas shares, according to the *Bullionist*, are falling. Something will have to be done by the gas companies. The question is, are we to have gas-electrics, gas, and electricity supplied from the same central station, or will the gas companies refuse or be unable to move?

Viscount Torrington.—We regret to have to record the death of Viscount Torrington, which took place on Sunday, October 20th, at Dinan, whether he had gone for the benefit of his health. Viscount Torrington was the chairman of Crompton and Co., Limited, also of the Crompton Electric Light Company of Australia. From this it may be taken for granted that Lord Torrington took a great interest in electrical engineering matters, and his early death is attributed in a great measure to overwork. Unfortunately, nowadays the great danger is from working at a high pressure—hence we have to deplore the loss of one whose sympathies were in the right direction, and whose help was valuable in the development of the new industry.

Chili.—The information department of the London Chamber of Commerce has issued the following circular relating to Chili: "The Consul in London for Chili has courteously replied as below (for the information of the Electrical and Allied Trades Section) to an enquiry made by the secretary of the London Chamber of Commerce: 'I should say that electrical machinery and electric lighting apparatus imported into Chili would come under the general head of machinery, and be subject to an *ad valorem* duty of 15 per cent. Motors of any class and such like have a fixed valuation of 25 cents per kilo. The exchange is adjusted periodically. The latest tariff I have is dated 1888, but should the interested parties to whom you refer wish to consult it, I shall be happy to allow them to do so at this office, Chilian Consulate, 50, Old Broad-street, E.C.'"

Messrs. Gatti and the Vestry.—The Works Committee of the St. Martin's-in-the-Fields Vestry meeting on October 17, reported that they had considered the action of Messrs. A. and S. Gatti, in taking up the roadway in the Strand, and having counsel's opinion, they recommended that Messrs. Gatti be informed that if at any future time they proceeded to take up any portion of the roadway, the Vestry would sue for the recovery of the statutory penalties. Captain Probyn said he hoped the Vestry would not put any impediment in the way of Messrs. Gatti, as they were large ratepayers, and they intended to supply their neigh-

bours with the electric light. Mr. Laing said Messrs. Gatti ought to be informed that if they did any work, such as opening trenches, they must first give notice to the surveyor, and any such work undertaken without due and proper notice would be carried out at their own risk. It was agreed to inform them upon the point.

Increasing Railway Traction.—The following details are forthcoming of the experiments with the electric traction increaser by means of a dynamo current passed through the rear driving-wheels to the rails. The experiments were carried out on the Trackville grade of the Pennsylvania and Reading Railroad, which averages 185ft. to the mile. With the dynamo running and a train of 45 cars attached to the locomotive, the ascent was made in 28 minutes. Without the aid of the electric agent, it is stated that the same locomotive train would occupy 55 minutes in covering the same ground. A low-tension current is used, and the increased friction, it is claimed, is under the complete control of the engine-driver. If the invention turns out to be of practical use, it will be of great advantage to railway companies, as it would obviate, in many cases, the use of an accessory engine to assist a train up a heavy incline. We shall need some better grounds than these to be convinced of the utility of this scheme.

Jobbery in Electric Lighting.—The following serious letter from Dr. Silvanus P. Thompson appeared in the *Times* of Oct. 21: "Sir,—This morning I received an enquiry from a gentleman of my acquaintance, whom I am not at liberty to name, informing me that a certain provincial town, which I would not mention for worlds, was about to provide itself with electric lighting, and suggesting to me that if I were to apply to become consulting electrical engineer to the municipality in question I should in all probability, if not certainty, be selected for that post. But my correspondent, who undoubtedly is in command of great local influence, was good enough to couple this suggestion with the information for my private ear that it was to be an understood thing that in laying down the future lighting station the boilers of a certain firm of Messrs. — were to be employed. I need not detail my reply to a proposition of such a nature, which I had more than one reason for declining. Only those who have investigated the matter know how deeply jobbery has seamed itself into municipal matters in relation to lighting by gas; as, indeed, the Salford and Halifax gas scandals have partially shown. It would be indeed deplorable if the same spirit of jobbery should enter into the newer industry of lighting by electricity."

Electric Tramcar.—An electric car was tried on the Bristol-road tramway route at Birmingham on Wednesday with entire success. The car is of the same size as the cars on the Birmingham cable tramway. It is lighted with electricity. The motor is in the front bogie, and the accumulators in which the electrical energy is carried are under the seats on both sides. It is expected that one of these cars will be able to run 70 miles with a single charge. This is a full day's work of the present cars. They are, however, only reckoned as half-day service cars, but the whole of the receptacle containing the power driving a car can be taken out at the depôt and recharged in the space of five minutes. The present car is the outcome of a recent union of interests between the Julien, the Sprague, and the Electrical Power Storage systems. It has enabled the Central Company to meet the hopes recently expressed that the ultimate form in which electricity might be applied

as the motive power of tramways in Birmingham should be the self-contained car and not a separate engine. Until recently a difficulty in the employment of large cars with self-contained power has been the use of the driving chain, which has been found in practice to be noisy and liable to break. But this difficulty has been quite overcome by an ingenious arrangement which absolutely dispenses with the chain, and which is practically noiseless.

Dundee.—The preliminary trials of the electric lighting in the Albert Institute, Dundee, have been very successfully tested in the presence of Mr. Bryson, consulting engineer; Mr. Alexander, city architect; Mr. Orchar, convener; ex-Provost Ballingall, Mr. W. B. Thomson, Mr. Maclauchlan, secretary; Mr. W. C. Martin, of Paterson and Cooper, the contracting engineers, etc. After darkness set in the lighting proved a magnificent success, both in the art galleries and the libraries, every part of the machinery working with perfect regularity and smoothness. The arc lamps, which are of the Phoenix type, of 2,000 c.p. nominal each, gave a brilliant light, without the slightest hissing or jumping, which is rather prominent sometimes in some types of arc lamps. The consulting engineer expressed his satisfaction with everything, and complimented the contractors on their superior workmanship, which was also confirmed by the other gentlemen present. The engine and dynamos were under the charge of Mr. Richardson, jun., representative of Messrs. Robey and Co., who have supplied the engine, which is an 80 h.p. compound Robey engine, with separate locomotive boiler of Messrs. Robey and Co.'s standard type for electric light installations. We may mention, also, that Messrs. Robey have supplied the engines for the Newcastle-on-Tyne lighting, the central station for which is in a forward state. Mr. John Hudson has charge of the electrical department at Dundee.

New Tape Machine.—A very ingenious and useful telegraphic recorder is being worked at the Haymarket Branch Office of the Telegraph Exchange Company. It is particularly deserving of attention in respect to newspaper offices, clubs, and other places where the ordinary tape instruments are in vogue. With the existing instruments sections of the tape when printed have to be cut or torn off and fastened down as readable lines on sheets of paper for the sub-editors and compositors, or for pinning on the news boards in clubrooms. The new instrument, which is the invention of Mr. Higgins, the engineer of the company referred to, prints its messages in lines upon the surface of a roll of paper 6 in. broad, so that the type-written slips, as cut off by the guillotine, appear much in the form of proofs of printing types set in galley. The ordinary tape machines print vertically. The new machine prints horizontally, so that a compositor could set direct from the machine, having the messages like a handbill on the wall before him. The cylinders of paper are of very convenient size, 3 in. in diameter, including the wood core, and 6 in. in length, corresponding to the breadth of the paper as it is unrolled. Each roll will take the impressions of 28,000 words, the rate of printing being 26 to 28 words per minute, and one winding of the clockwork gives effect for 5,000 words. The motive power for the paper cylinder is derived from the gravitation of a heavy weight; the actual printing is done by the electric current.

Bradford.—A special meeting of the Bradford Town Council is to be held to-morrow morning for the purpose of considering resolutions relating to the proposed new tram-

ways. The Gas and Electricity Supply Committee will also ask for the approval of the Council to a resolution to borrow an additional sum of £25,000 "for extensions of the electricity works required to meet the growing demands for electric lighting." In explanation of this proposal, it may be stated that the sum originally authorised to be borrowed has already been expended, and that the area of supply, which is restricted, cannot be extended without some further expenditure for mains. Applications are coming in almost daily for the light, and strong representations are being made to induce the committee to extend the mains. The Bradford Club and the new School Board offices are wishful to have the electric light, and the officials at the Town Hall, the rooms of which are badly ventilated, are said to contemplate memorialising the committee to the same effect. It is anticipated that before Christmas the capacity of the plant at present in use will be well-nigh exhausted, and that for the economical working of the installation it will be advisable to lay down a number of accumulators, and possibly to add to the number of engines and dynamos. But it is not intended to expend any large proportion of the sum for which it is suggested that borrowing powers should be obtained. The success of the installations so far effected has more than equalled the most sanguine anticipations, and, of course, the committee are bound to treat with consideration all reasonable applications.

Electrical Applications.—Mr. Foree Bain gives an amusing account, in the *Electrical World*, of the various odd ideas he is called upon in the course of his profession to carry out. One man wants "an instear meant that i can find gold or silver three feat undear ground." Another gentleman, intelligent enough on other subjects, furnished a design to pump electricity out of the ground; still another, a machine to vitalise goose eggs, to improve the breed of geese. Notwithstanding these oddities, there does seem to be a large field likely soon to be opened for electrical engineers to construct electrically-worked machines for many special purposes. Mr. Bain says: "I am frequently called upon to invent and devise all kinds of machines with which the mysterious power of electricity is to 'revolutionise' something or other. Quite a number of the ideas and suggestions offered are novel, and a number of the machines which are made to carry out the 'ideas' prove to be very practical and valuable. In a great many cases a 'vague idea' is the only basis they give upon which to devise and construct a machine or apparatus that will when completed contain a dozen or more important inventions. It is remarkable how all the branches of industry are looking to electricity as a means to more cheaply or rapidly perform the various operations incidental to manufactures of all kinds. A more general education in the art of electricity will no doubt increase its use in the various shops and factories throughout the world. There are now a number of articles manufactured which could be greatly cheapened and the process quickened by using electrically operated mechanism."

Leeds.—At a meeting of the Leeds County Council in July, the Electric Lighting Committee were authorised to light by electricity parts of the Town Hall and Municipal Buildings, as set forth in the report then presented to the Council, at an estimated expenditure of £3,000. Portions of the work have been already carried out, and at a meeting of the committee just held it was decided to proceed further with the installation to the extent of lighting the rate offices in the Municipal Buildings and the police offices in the Town Hall. This is, of course, entirely in

dependent of the larger scheme for lighting portions of the borough, which the Council shelved at its last meeting. Some discussion took place as to the exact meaning of the Council's resolution postponing the scheme for 12 months. It was contended that the Council implied by their resolution that the committee should cease to do anything in the way of public lighting for six months. Ultimately it was agreed not to put too literal a meaning on the Council's decision, but to continue making enquiries as to electric lighting improvements. The Town Clerk stated, as a curious coincidence, that the Nottingham Corporation, having, at their own expense and with sanction, obtained copies of the Leeds electric lighting report, had, after carefully considering the arguments used therein, actually decided to apply to Parliament for a provisional order. The Leeds Corporation, on this same report, refused to apply for an order. A letter was read from the Yorkshire House-to-House Electric Lighting Company, in which it was stated that the company intended to apply for a provisional order for Leeds, and asking the assistance of the committee in their application. On the proposal of Alderman Spark, seconded by Councillor Willey, the letter was referred to the Council. This being the last meeting of the committee for the present municipal year, a vote of thanks to the chairman (Mr. W. H. L. Hardwick) for his services during the past year was adopted.

Telegraphs in China.—The latest official list of the Chinese Telegraph Administration enables us, says the *Times*, to estimate the marvellous extension of telegraphs in China during the past few years. There were 136 stations opened when the book was compiled, from Peking in the north to Chung-fah, in Hainan Island, in the south. There are now, roughly speaking, three main lines; the first, starting from the foreign concession in Tientsin, goes in a gigantic curve through Chining, Chinkiang on the Yangtsze, Soochow, Hangchow, and thence along the coast through Foochow, Amoy, Swatow, and Canton, up the West River to the frontier of Tonquin. The second starts at Chinkiang and, going up the Yangtsze valley to Luchow, in the extreme west of China, turns southward through the capital of the Kweichow province, through Yunnan, and at Momein on the Burmese frontier turns westward towards Tonquin, and stops at a distance of 60 miles from the terminus of the first line. But since the list was issued the gap has been crossed, and the enormous circle, which, starting from Chinkiang, embraces all China south of the Yangtsze, is now complete. The third main line runs from Peking, through Tientsin, to Kirin in Manchuria; thence three lines branch off, one to Aigun on the Amour; one to Hun-chun, where the Chinese, Russian, and Korean frontiers meet; and the third to Seoul, the capital of Korea. There are several branch lines from these main routes. Tientsin is connected with Paoting, the provincial capital of Chihli province; Newchwang and the arsenal at Port Arthur are joined; at Hun-chun and Aigun the Chinese lines join those of the Russian Siberian system; the line to Seoul is extended to Fusan and joins the Japanese cable; a second line to Canton, through Kinkiang on the Yangtsze, has lately been constructed. In fact, it is easier to say where the telegraph is not than where it is. The remote provinces of Shansi, Shenpi, and Kansu are untouched; so is Hunan, while Honan is connected only at its capital, on its north-east border. Only one treaty port, Wenchow, is without the telegraph. The lines are divided into official and commercial. The former

include the extension along the Tonquin frontier, and thence northward to Luchow, near Chunking, in Szechuan, the Korean and Manchurian lines, and the Formosa cable.

Harrogate.—A special meeting of the Harrogate Town Council was held last week to take into consideration notices from the following companies of their intention to apply to the Board of Trade for provisional orders to supply electricity for any public or private purposes within the borough of Harrogate—viz., the Laing, Wharton, and Down Construction Company, Limited; the Electric Construction and Maintenance Company, Limited; and the National Electric Supply Company. Mr. Crichton (on behalf of Mr. A. M. Bateson, solicitor for the Corporation) read a report on the question. Alderman Simpson proposed, "That in pursuance of section 1 of the Electric Lighting Act, 1888, the consent of the Council be not given to the obtaining of such provisional orders by any of the said companies." Mr. Oxley seconded. Alderman Ellis said that the lighting by electricity was yet in its infancy, and that at present it would be more expensive than gas. He did not think that it was prudent to run the risk of handing over any powers they possessed to any of the companies. They were not at present prepared to say what they would do, but they ought to decline to grant anything of the kind at present. Alderman Taylor said he believed it would be the light of the future. Already at several watering-places it had been introduced, and although it was much more costly it assisted in keeping up the prestige and popularity of those places. It was a question that should be kept well before the Corporation, as they did not know how soon it would become general. Mr. D. S. Ward thought they should do something more than merely dissent from the proposal. It had already been demonstrated that electricity was greatly superior to gas, and Government institutions and various bodies had been testing it for some time. It had been utilised at the General Post Office with great success; and in one department since the installation of the light £600 had been saved from fees paid for sickness of the operatives, which otherwise arose from gas. He considered it was essential not only to oppose, but to have no further monopolies whatever, as they already had sufficient in the town. He proposed that a sub-committee be appointed to thoroughly consider the matter, and watch the system as it developed, and report to the Council, in order that they might be prepared for any emergency. After further discussion the resolution was carried unanimously, and a sub-committee was formed from the members of the Council.

Constant Speed Tramway Motors.—The worst defect in the existing method of electric cars, says Mr. George Westinghouse, is the necessity for stopping and starting the motor each time the car is started. When an electric motor is started its efficiency is at the zero point and the consumption of electricity is excessive, often resulting in the destruction of an "armature" or "field." Every person has noticed the terrific effort horses have to make in starting a loaded car, which is afterward moved along so easily. In like manner the electric motor has to exert its greatest force in starting a car, and, like its predecessor, is often seriously injured in its effort. To obviate this greatest difficulty has led to the use of large motors, being in effect the same as if two teams were put to each car. The horses would not be injured by the strain, but they would eat twice as much, and consequently increase the cost of operating. The use of large motors that are stopped and

started with the car, and the consequent low average electrical efficiency, necessitates large electric generating apparatus with correspondingly large engines and boilers. Not only does the present system require this larger capacity of electric generating apparatus, but it requires a greater and more dangerous current to be carried overhead. It is estimated that less than 20 per cent. of the power is expended by the engines doing effective work when cars are stopped and started frequently, though when a motor is just the size required, and is run at its right speed, an efficiency of 80 per cent is possible. To avoid loss of power demands the use of a motor constantly run at its critical speed, or that speed at which the highest electric efficiency is obtained; with a motor in constant motion, the momentum of the armature becomes a positive advantage, unlike its inertia, which is a serious disadvantage when started from rest. If the motor runs at a constant speed, then there is required only a suitable device to be interposed between the motor and car axle, whereby any rate of rotation of the car axle can be had at the will of the attendant. The Westinghouse Electric Company has perfected one form of device having the customary gears, whereby the above described feature is accomplished in a simple and effective manner, thus enabling the use of properly proportioned motors of moderate capacity, requiring less than half of the electricity heretofore thought necessary. A second form, that will dispense with the objectionable gearing, and that will permit of a wide variation of the relative speeds of the motor and car axle, is approaching completion, and when all the details are properly proportioned will be the ideal device.

London County Council.—At the last meeting of the Council the report of the Highways Committee was moved and adopted to the effect: "That, subject to the recommendation of the Finance Committee that the necessary costs be incurred, it be referred to the Parliamentary Committee to prepare and introduce into Parliament in the ensuing session a Bill conferring the following powers, amongst others, upon the Council—viz. (a) As to overhead wires.—(1) To compel owners of existing wires to register same, with route plan and other particulars, at the office of the Council within 12 months of the Bill becoming law, such register to be corrected annually; (2) to require in the case of new wires plans to be submitted for approval of Council before erection; (3) to remove ownerless wires; (4) to call upon owners to make alterations, repair defects, or renew; (5) to make by-laws and regulations as to length of span across roads and streets, height, mode of support, material, and gauge of wires; (6) to authorise in special cases attachments to private property, subject to the question of compensation or payment by the wire owners for such privilege, and to the attachments not interfering with the free use of the property; (7) to employ inspectors; (8) to prescribe that wires be carried underground; (9) to charge a fee for annual registration. (b) As to subways.—To construct subways of such form and size in such thoroughfares or streets, and at such convenient times as the Council may deem desirable; (2) to compel owners of gas and water or other pipes and wires to use subways where made, and to remove existing pipes and wires into subways; (3) to charge rent for use of subways, and grant use of subways free for a given period as compensation in cases of compulsory removal to (4) to acquire by agreement the

whole or portions of vaults or cellars under public streets when required to enable subways to be constructed; (5) to alter, for the purpose of construction of subways, the position of sewers, pipes, wires, and other works in streets on payment of actual costs only of structural alterations; (6) to call upon gas and water and other companies to supply plans and full particulars of any pipes, wires, or other works belonging to them in any streets along which it may be suggested that subways should be laid; (7) to call upon gas and water and other companies to deposit plans and obtain the approval of the Council for any proposed alteration, renewal, extension, or addition to existing pipes, wires, or works in any thoroughfare or street; (8) to remove all disused pipes or works in public streets; (9) to make regulations for the use of subways."

Great Yarmouth.—Mr. Cockrill, the borough surveyor, has submitted a report to the Town Council relating to the electric lighting of the borough. Among other things, he says: "I feel that I am very much hampered by your instructions, as lighting the public streets and roads of a town without providing for giving a supply to private individuals has never been attempted. At Bradford, the first Corporation to complete an installation for public lighting, they have found that private individuals have taken up the whole of the lights (4,000) which the plant put in was capable of supplying, although the gas undertaking is the property of the Corporation, and is supplied at 2s. 3d. per 1,000 cubic feet, with liberal discounts, while the Corporation are supplying electricity at 5d. per Board of Trade unit, which the public were told was equal to gas at 4s. per 1,000. As to the actual cost of electricity compared with gas, experts very much differ. In my last report I gave the cost of electricity, as compared with gas, at 3s. 9d. per 1,000. I have had, since making that report, an offer from eminent electricians to put in an installation and supply electricity at 3½d. per Board of Trade unit, which they claim as equal to gas at 3s. 3d., this price to include all interest, capital charges, and allowances for depreciation. . . . Some very important installations are now drawing near completion, and within 12 months the result of their working will be known, and the estimate now given will be proved. I would urge upon the Council that it is advisable that they should seek to obtain powers themselves, and that such powers should extend to the whole of the borough, including the portion which will be added by the recommendation of the Boundary Commission, as it may be expected that railway companies will be good customers. I would further ask that the instructions to me should be amended so that they include the question of providing lighting to private consumers, and for this purpose enquiries should be made, either by advertisement or by canvass, to ascertain the requirements of the public. My opinion is that a small installation could be commenced, providing for lighting the busiest portion of the town, as Regent and King streets, and such open spaces as the Market Hall Quay and Marine Parade, places in which the increase of light would be a great benefit, and in which more light is needed. The leads to these positions would be in close proximity to property, which I am certain would be good customers for the light, while the Council might provide it to the Town Hall, and thus save a large sum in ventilating the Assembly-room, which it is determined is necessary. If properly designed such an installation as I have sketched out could gradually be extended, and would pay its way."

LAHMEYER'S SYSTEM OF DYNAMO REGULATION AND ELECTRICAL DISTRIBUTION.

BY LEONARD PAGET, PH.D.

Among the several methods of rendering dynamo regulation automatic that have been recently introduced, it is somewhat unusual to find one embodying so entirely novel features as that designed by M. Lahmeyer, nor one having such general application. Instead of producing uniformity of work by alteration of resistance, M. Lahmeyer substitutes for the variable resistance a variable E.M.F., foreign to the E.M.F. of the generator. For example, let us consider the case of a series motor making a constant number of revolutions under variable loads, and supplied with a constant current. The product of the effort of traction exerted by the motor, multiplied by its

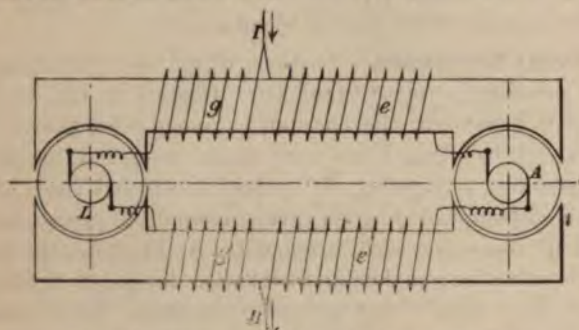


FIG. 1.—Lahmeyer Regulation and Distribution.

velocity of rotation, is manifested externally by its work evaluated in horse power. The condition imposed being that the number of revolutions is constant, it is necessary that the effort of traction be made to vary proportionately to the external load. For each motor in series this effort is equal to the product of a constant by the amount of current in the armature and by the number of lines of force cut by the armature. It is then required to vary the number of useful lines of force, and consequently, the E.M.F. at the terminals of the motor in correspondence with the variations of the external load. This is attained by varying the ampere-turns employed in excitation.

We can arrive at this result by the aid of a centrifugal regulator connected to an adjustable resistance intercalated in parallel with the winding of the electromagnets, in such a way that when the number of revolutions increases the resistance in the shunt diminishes, and inversely.

Another arrangement would consist in dividing into a certain number of sections the series winding of the electro-

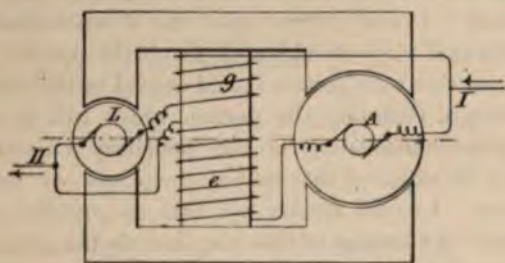


FIG. 2.

magnets. We connect the leading wires to these sections so as to make a diminution of the number of revolutions correspond to a greater number of turns of the electromagnet coils traversed by the current, and inversely.

These arrangements have a common inconvenience that limits their use. The necessary variation of the ampere-turns of excitation, from full to no load, is extremely limited. This requires a multiplicity of contacts to be traversed by the lever arm of the regulator, and gives to this arm too great amplitude of oscillation from its mean position.

M. Lahmeyer resolves this difficulty by introducing the contrary E.M.F. of a freely-revolving armature (that is to say, having no load). The motor has two armatures, one of which does work, the other regulates.

The arrangement admits of much modification, according to the system of circuits. One consists in putting the arma-

ture in series with the winding of the electromagnets. Parallel to this circuit is a second, comprising the regulating armature put in series, with a second winding of the electromagnets acting oppositely to the first. The second winding has, therefore, a differential action. M. Lahmeyer terms the first, the exciting winding, and the second, the opposed winding.

Fig. 1 represents the arrangement diagrammatically. A is the working armature, e is the exciting winding, L is the regulating armature, g is the opposed winding.

The current enters at I, and divides between the two branches, e A e and g L g, issuing at II. The two armatures revolving free from load, the currents will be respectively, I e and I g. In this case the number of ampere-turns will be m e I e and m g I g, designating by m e and m g, the number of turns of e and of g.

The windings, e and g, are naturally so calculated, that the number of ampere-turns of the first may preponderate

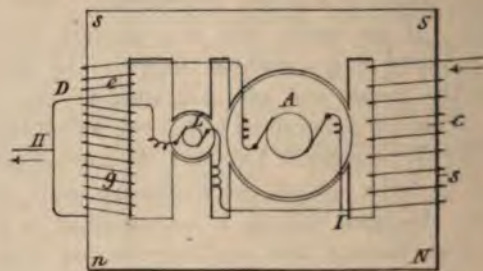


FIG. 3.

and the difference be positive. If, however, the armature, A, becomes loaded with work, its contrary E.M.F. is lowered and the branch e A e will immediately take more current. Supposing that the new quantities are I e and I g, it is evident that the useful number of ampere-turns, m e I e and m g I g, will be greater than the preceding, because I g has become greater and consequently I e has diminished. When the load on A is reduced, the converse occurs.

A proper calculation of the windings of the two branches would admit of "compounding" the motor in a measure, so that the arbitrary load on A, by modifying the subdivision of the current I, produces under the differential action

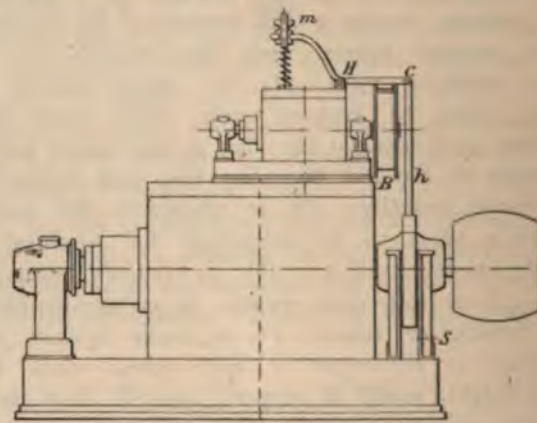


FIG. 4.

of the two windings the exact number of ampere-turns required for the motor to make under that load the given number of revolutions. The regulation is aided by the fact that as a whole the displacement of current has the effect of slightly increasing the intensity in the working armature when the load increases.

The arrangement of the two armatures in series in the magnetic circuit requires that these should be of nearly identical dimensions, but, on the other hand, that the regulating armature may be very small relatively to the other, it is preferable to arrange the armatures parallel, as regards their magnetic fields (Fig. 2).

The two armatures may, of course, be each in a separate motor. Neither is it necessary to produce the magnetic field of the regulating motor in the same manner as that of the working motor, that is, by means of two windings having differential action. The velocity of rotation of this

armature being determined, it is always possible to obtain the contrary E.M.F. necessary to regulation by modifying this velocity, so that its magnetic field varies with that of the working motor in the manner previously indicated, or so that the field remains invariable. The exciting current may therefore be obtained from a third source, or by employing permanent magnets.

Fig. 3 shows another arrangement, which consists in regulating the magnetism of a dynamo by varying the ampere-turns of excitation by a magnetic derivation. C is the branch of the electromagnet proper, magnetised by the winding, S, intercalated in the circuit. The branch, D, constitutes, when feebly magnetised, a magnetic derivation (shuntkeeper) that weakens the field in which the armature revolves. From the winding, S, the circuit subdivides at I, one part running to the working armature, A, and the exciting coils, *e*, and the other part to the regulating armature, L, and the contrary winding, *g*. The two windings are taken round D. The one, *e*, has a magnetising action in the direction indicated conventionally by the letters *ns*; the other, *g*, a demagnetising action. Increase of load increases the current in the first to the detriment of the current in the second. Thence results the desired increase of the intensity of the magnetic field. The conditions of regulation tending to maintain a constant number of revolutions are thus realised.

These arrangements, and others that M. Lahmeyer has developed at considerable length, restores the principle of employing an armature turning without load in the guise

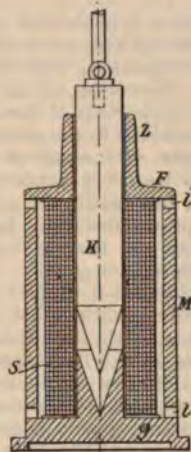


FIG. 5.

of a variable resistance, to regulate the number of revolutions of the working armature of an electric motor, while by consequence of the arrangement of circuits employed the speed of the regulation armature varies according to requirement. The condition of this method is that the current delivered to the motor remains constant.

It is possible to release this condition within limit by regulating the velocity of the small armature by means of a centrifugal regulation worked by the main armature. Let, however, there be put under consideration the application of a regulating motor, or in other words a regulating armature, to the dynamos generating the current. Suppose the current constant, and that there be employed a brake acting automatically on the regulating armature. On this brake, by means of a spring, a weight on the one hand is caused to act; on the other hand, a coil traversed by the current to be maintained constant, and the action of which is antagonistic to the mechanical system. Fig. 4 represents a simple method. S is a main current coil acting on an electric piston and thereby on the levers H and h, and on the antagonistic spring adjusted by the screw, *m*. B is a friction pulley.

For the coil in the main circuit, M. Lahmeyer prefers the following construction, shown in Fig. 5. The core, K, of the coil, S, is movable and is raised by the antagonistic effort of the spring. In the region of strongest attraction the core takes the form of a cone, in face of which is sunken a conical cavity in the base of the iron sheathing, *g*, of the bobbin. This base is connected to the cover, F, by the sheathing, M, drilled with airholes, *l*. This cover is prolonged by an iron cylinder, Z, enclosing the moving core for

a portion of its length, with but a small space between the two pieces of iron. The lines of force traverse iron in all parts except the short distance between the conical parts of the core and base. Consequently, the bobbin produces, with a comparatively small number of ampere-turns, a large number of lines of force and considerable attractive force.

Fig. 6 is an arrangement in which the regulating armature is mounted on a separate foundation. The current produced in the armature, A, subdivides at I between the two windings, *g g'* and *e e'*, and through the former to the

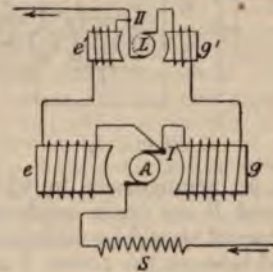


FIG. 6.

regulating armature, whence from II both pass to the external conductor. The undivided current enters by the bobbin, S to A. If this current is too strong, the coil, S, draws down the brake, which allows more current to flow through *g* and *g'*, weakening the E.M.F. and current output of the machine. If the current is not strong enough, the converse occurs by consequence of the raising brake.

As an instance of sensitiveness, suppose a current of 20 amperes traversing the bobbin, S. In this case the force of attraction of the bobbin on the core is 1,900 grammes. The spring acts in a contrary direction with a force equal to 1,820 grammes. The mean pressure on the brake is 80 grammes. If the current increases to 21 amperes the attraction of the bobbin becomes 1,980 grammes, and the spring force remaining the same, the brake pressure is 160 grammes, that is, double its mean value. Consequently, since small variations in the current to be maintained constant produce immediately important variations in the brake-pressure, it follows that the regulating power is extremely sensitive, and that considerable changes in the load as well as in the speed are without effect.

The contrary windings, *g* and *g'*, may be omitted, and the regulation effected by variations of the current, *e* and *e'*, only.

If constant E.M.F. is desired, choice should be made of a dynamo shunt excited, and the regulating armature inserted in the shunt instead of the ordinary adjustable resistance. The brake is then actuated by a fine wire coil, S, put in shunt across the terminals with an antagonistic

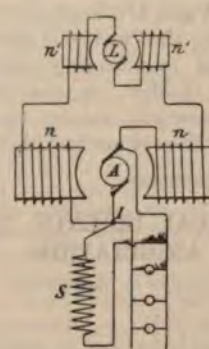


FIG. 7.

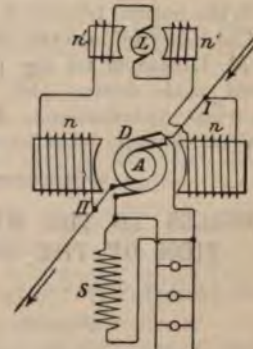


FIG. 8.

spring, so that too low tension at the terminals of the bobbin causes binding of the brake and reinforces the current in the shunt-magnets.

Dynamos to be run parallel could be constructed with a single armature, carrying at the same time the motor-winding with its collector and the dynamo-winding with its collector respectively. This case is represented in Fig. 8 by the concentric collectors, A and D. The same magnetic frame encloses the two windings, and the excitation is taken in shunt, *n*, across the terminals, I and II, of the

motor. There is intercalated in this shunt, according to the arrangement shown in Fig. 7, the windings of the electromagnets, $n' n'$, as well as the armature, L , of the regulating motor. Both the necessary brakes of this armature are actuated by the coil, S , put in shunt on the main conductors. For the adjustable resistance usually employed in electrical distribution at central stations to maintain constant the E.M.F. at a distance on long lines, may be substituted the regulating motor.

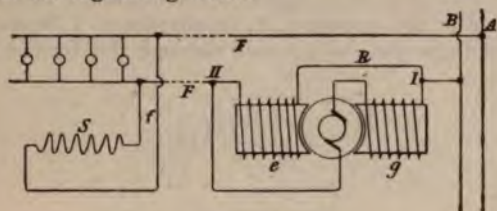


FIG. 9.

Fig. 9 shows an arrangement in which this is carried into effect. A and B are main conductors, in which the difference of potential should be maintained constant. The motor is inserted between the points, I and II, in the line the terminal tension of which is to be kept constant. The branch, I R e II, includes the exciting coils, e , of the electromagnets and a high invariable resistance, R . The branch, I g L II, includes the armature of the regulating motor, L , and the demagnetising windings, g , of the electromagnets. L and g have relatively low resistances. The bobbin, S , is submitted to the action of the distant E.M.F. by special conductors, ff . It so acts on the brake system already described as that if the distant E.M.F. is lower than the normal E.M.F., the breaking of the motor increases, and inversely. The regulation by the motor is, as a rule, in these cases, related to a minimum limit of current in the line. It is possible to determine this limit. Suppose that it be one-tenth of the maximum current, the motor will then act so that a current of a value equal to one-tenth of the maximum current will determine the minimum charge or load of the brake. The greater part of the current traverses the branch I R e II. The motor then receives a greater number of lines of force, and L develops a high contrary E.M.F. As $R + e$ constitutes also a high resistance, the motor will absorb the least possible tension. This is precisely what is to be attained, because owing to the small current in the line F , the loss of E.M.F. is small. If the current in $F F$ increases, the E.M.F. falls. But it also results that the brake acts, and the current in the motor follows preferably the branch I L g I I. The number of lines of force and the contrary E.M.F. of the motor diminish, so that the motor absorbs less E.M.F.

When the current in F is at maximum, $m g I g$ is nearly equal to $m e I e$. The number of lines of force can be neglected, or, in other words, the armature is nearly at rest. The distant tension does not then sensibly differ from the normal tension if that in A and B is kept constant.

The foregoing are the chief among the methods devised by M. Lahmeyer for the purpose of maintaining constant speed with motors and constant E.M.F. or current in electrical distribution. I may presently return to this subject, showing what has recently been done by others.

ADDRESS TO THE MECHANICAL SCIENCE SECTION OF THE BRITISH ASSOCIATION.

BY WILLIAM ANDERSON, M.I.C.E., PRESIDENT OF THE SECTION.

(Concluded from page 319).

But the mean specific gravity of the earth as determined by Maskelyne Cavendish and others certainly exceeds five, and consequently the inner portion of our globe must be composed of substances heavier than those existing on the surface, and such substances are only to be found among the elements with high atomic weights. The question arises, "What elements of this character are we likely to find in the depths of the earth?" In the first place, since gases diffuse through each other, a certain proportion of the elements of high atomic weight will also be found on the surface of the earth. Secondly, the elements forming the bulk of the earth must be found in the atmosphere of the sun—if, indeed, the earth once formed part of its atmosphere; and of all the elements, iron, with a specific gravity exceeding seven, and with an atomic weight of 56, corresponds

best with these requirements, for it is found in abundance on the surface of the earth; and the spectroscopic has revealed the very marked presence of iron in the sun, where it must be partly in the fluid and partly in the gaseous state; and consequently iron in large masses must exist in the earth, so that the mean specific gravity of our planet may well be five, the value which has been determined by independent means.

It is not easy, however, to define in what condition the mass of iron which must exist in the heart of the earth is likely to be. Iron is capable of forming a vast number of combinations, depending upon the relative proportion of the various elements present. Thus, in the blast-furnace, oxygen, carbon, nitrogen, calcium, silicon, and iron are associated, and produce, under the action of heat, besides various gases, a carburet of iron and slag, the latter containing chiefly silicon, calcium, and oxygen, that is to say, substances similar to those which form the bulk of the surface of the earth. But these same elements, if there be an excess of oxygen, will not yield any carburet of iron, and the same result will follow if there be a deficiency of silicon and calcium, because of the large proportion of oxygen which they appropriate. In the same way, during the cooling of the earth, if oxygen, carbon, and iron were associated, and if the carbon were in excess of the oxygen, the greater part of the carbon would escape in the gaseous state, while the remaining part would unite with the iron. It is certain that, in the heart of the earth, there must have been a deficiency of oxygen, because of its low specific gravity; and the argument is supported by the fact that free oxygen and its compounds, with the lighter elements, abound on the surface. Further, it must be presumed that much of the iron existing at great depths must be covered over and protected from oxygen by a coating of slag: so that, taking all these considerations into account, it is reasonable to conclude that deep down in the earth there exist large masses of iron in part at least in the metallic state or combined with carbon.

The above views receive considerable confirmation from the composition of meteoric matter, for it also forms a portion of the solar system, and originated, like the earth, from out of the solar atmosphere. Meteorites are most probably fragments of planets, and a large proportion of them include iron in their composition, often as carbides, in the same form as ordinary cast iron—that is to say, a part of the carbon is free and a part is in chemical union with the iron. It has been shown, besides, that all basalts contain iron, and basalts are nothing more than lavas forced by volcanic eruptions from the heart of the earth to its surface. The same causes may have led to the existence of combinations of carbon with other metals.

The process of the formation of petroleum seems to be the following: It is generally admitted that the crust of the earth is very thin in comparison with the diameter of the latter, and that this crust encloses soft or fluid substances, among which the carbides of iron and of other metals find a place. When, in consequence of cooling or some other cause, a fissure takes place through which a mountain range is protruded, the crust of the earth is bent, and at the foot of the hills fissures are formed; or, at any rate, the continuity of the rocky layers is disturbed, and they are rendered more or less porous, so that surface waters are able to make their way deep into the bowels of the earth, and to reach occasionally the heated deposit of metallic carbides, which may exist either in a separated condition or blended with other matter. Under such circumstances it is easy to see what must take place. Iron, or whatever other metal may be present, forms an oxide with the oxygen of the water; hydrogen is either set free or combined with the carbon which was associated with the metal, and become a volatile substance—that is, naphtha. The water which had penetrated down to the incandescent mass was changed into steam, a portion of which found its way through the porous substance with which the fissures were filled, and carried with it the vapours of the newly-formed hydrocarbons, and this mixture of vapours was condensed wholly or in part as soon as it reached the cooler strata. The chemical composition of the hydrocarbons produced will depend upon the conditions of temperature and pressure under which they are formed. It is obvious that these may vary between very wide limits, and hence it is that mineral oils, mineral pitch, ozokerit, and similar products differ so greatly from each other in the relative proportions of hydrogen and carbon. I may mention that artificial petroleum has been frequently prepared by a process analogous to that described above.

Such is the theory of the distinguished philosopher, who has framed it not alone upon his wide chemical knowledge, but also upon the practical experience derived from visiting officially the principal oil-producing districts of Europe and America, from discussing the subject with able men deeply interested in the oil industry, and of collecting all the available literature on the subject. It is needless to remark that Dr. Mendeleeff's views are not shared by every competent authority; nevertheless, the remarkable permanence of oil wells, the apparently inexhaustible evolution of hydrocarbon gases in certain regions, almost forces one to believe that the hydrocarbon products must be forming as fast as they are consumed, that there is little danger of the demand ever exceeding the supply, and that there is every

prospect of oil being found in almost every portion of the surface of the earth, especially in the vicinity of great geological disturbances. Improved methods of boring wells will enable greater depths to be reached; and it should be remembered that, apart from the cost of sinking a deep well, there is no extra expense in working at great depths, because the oil generally rises to the surface or near it. The extraordinary pressures, amounting to 300lb. per square inch, which have been measured in some wells seem to me to yield conclusive evidence of the impermeability of the strata from under which the oil has been forced up, and tend to confirm the view that it must have been formed in regions far below any which could have contained organic remains.

The weights and measures in use in this country are a source of considerable trouble and confusion. Besides the imperial measures, which are complicated enough, a great number of local units are in use, so that unwary strangers are not unfrequently deceived, or, at any rate, if they hope to escape from mistakes, have to apply themselves to the study of local customs. In the scientific world, again, the metric system is now almost exclusively used, and the same may be said of engineers and manufacturers who have to do with foreign countries in which French measures are in vogue. The same difficulty surrounds the measurement of the power of motors. The unit of power is, indeed, from the nature of the case, common to the whole world—it is unit of weight multiplied by unit of height—and with us the foot-pound, or 33,000 times the foot-pound, is generally accepted; but the difficulty lies in determining how the measure is to be applied. Thus, in the case of a water-motor—should the power be calculated by the energy latent in the falling water, or in the actual work given off by the motor? In heat-engines, we have to deal with many variables. There is the initial pressure of the working agent, the terminal pressure, the length of stroke, the number of revolutions per minute, the indicated power in the cylinder, the effective power given off, and the adequacy of the means of supplying the working agent. In the early days of steam, when pressures were pretty uniform, and speed bore a certain relation to the stroke, the diameter of a cylinder was a tolerably close index to the power of the engine, and such simple rules as "10 circular inches to the horse-power," which prevailed among agricultural engineers, was tolerably intelligible. But in these days, when pressures, speeds, and rates of expansion vary so greatly, the size of the cylinder or cylinders is no longer a guide, and imagine that most manufacturers have ceased to class their engines by their nominal horse-power. The problem is pretty simple in the case of pumping-engines, for there the nominal power may be taken, as it is in Holland, to be the actual work performed upon the water, and perhaps a similar rule might apply to motors driving dynamos, but for most other purposes no simple law is possible. In my own practice I have, for many years, been in the habit of classing engines by the indicated horse-power per one revolution for every probable initial pressure, below the maximum one for which the engines were designed, and for various rates of expansion. To facilitate the calculations I use curves which give the theoretical horse-power, on the supposition that steam expands according to Boyle's law, for 10,000 cubic inches of steam measured at the moment of exhaust, which is, in fact, the volume of the cylinder in single-cylinder engines, and the volume of the last cylinder in compounds. These curves are calculated for initial pressures rising by 25lb., and, in non-condensing engines, for the extreme range of expansion possible, and to fourteen expansions in condensing engines. The true indicated horse-power ranges from 80 per cent. to 85 per cent. of the theoretical, as above stated, the precise percentage depending upon the construction of the engine. As large engines are now almost always compound, the size of the cylinders is no guide to the lay mind; hence, in answering enquiries, it is necessary by some means to get at the actual horse-power expected and to settle the initial pressure, for on this point there is still much timidity among steam users, so that the engine-builder has to adapt himself in this, and other particulars, to the needs or prejudices of his customer.

In marine engines, again, the difficulty is still greater, because the only measure of the effective power of the engines is the speed of the ship under given conditions of immersion. But the resistance of ships is a complicated matter, not perfectly ascertained yet, so that the speed attained in any new combination of engines and hull is by no means a certainty; hence some recognised measure of the power of a marine engine, depending only on the measurement of the cylinders and boilers, becomes very desirable.

So strongly has the want of a standard horse-power been felt by shipbuilders and marine engine makers that the council of the North-East Coast Institution of Engineers and Shipbuilders appointed a committee to investigate the subject, and to devise, if possible, a set of rules which would be generally acceptable. The committee made its report in the spring of 1888. They took as their basis the indicated horse-power, under certain normal conditions, and propose to call this the normal indicated horse-power (n.i.h.p.). The normal conditions are, briefly, the following:

1. That the steam, of whatever boiler pressure, is expanded to the same terminal pressure.

2. That the expansion is effected by all engines with the same degree of efficiency.

3. That the piston speeds of engines of different lengths of stroke are proportional to the cube root of their respective strokes, and, further, that the actual loaded trial trip value of piston speed may be taken as 144 times the cube root of the stroke in inches ($144 \sqrt[3]{S}$).

4. That in cases in which the engines and boilers bear to each other such proportions as to prevent condition 1 from being fulfilled without thereby violating condition 3, the coal consumption per indicated horse-power will not be affected, but will be constant for the same boiler pressure.

5. That the boilers are constructed in accordance with what will be generally recognised as the average practice of the present day in respect of the allowance of steam room in relation to power, the diameter, area, and pitch of tubes, the relation of grate to heating surface, and the area of uptakes and funnel; that average natural chimney-draught is used, or, if forced draught be employed, that it does not exceed the natural draught; that the horse-power is proportional to the heating surface (H.), and to the cube root of the pressure ($\sqrt[3]{P}$); and, further, that the actual loaded trial trip horse-power may be taken as equal to one-sixteenth of the heating surface multiplied by the cube root of the pressure $\frac{(H \sqrt[3]{P})}{16}$.

6. That the efficiency of the engine mechanism is constant, and that the propeller is such as to secure that the engines will utilise the boiler power referred to in condition 5 in the manner prescribed by conditions 3 and 4.

Subject to these conditions the normal indicated horse-power is found by multiplying the square of the diameter of the low-pressure cylinder in inches by the cube root of the stroke in inches, adding to the product three times the heating surface of the boiler in square feet, multiplying the sum by the cube root of the pressure, and dividing the product by 100.

$$N.I.H.P. = \frac{(D^2 \sqrt[3]{S} + 3H) \sqrt[3]{P}}{100}$$

It is evident from this formula, and from the conditions, that account is taken of all the variables, and that the boiler is regarded as an integral part of the engine. The report gives several useful formulæ deduced from the above. Whether the expressions given are the most convenient possible for general marine practice or not I am not competent to say, but it seems to me that a step has been taken in the right direction in the attempt which has been made to measure marine engines by some rational standard. The members of the committee were all thoroughly practical as well as scientific men; they determined their constants by reference to a large number of successful cases; and I sincerely hope that the question will be pursued by the marine engine builders on the West Coast, and by the constructors of land engines. As engineer to the Royal Agricultural Society, I have frequently had to define the power of engines entered for competition for the society's prizes, and I have experienced the greatest difficulty in laying down rules for the guidance of intending competitors, being fearful, on the one hand, of restricting originality, and, on the other, of admitting engines of greatly varying powers.

I have expressed an opinion that the numerous engineering societies which exist at this day have it in their power to promote the advancement of mechanical science in a notable manner by appointing research committees, or by aiding individual investigations from their abundant means. The North-East Coast Institution of Engineers and Shipbuilders has done good service in their endeavours to establish a practical measure of the power of marine engines, while the Institution of Mechanical Engineers has, for the last ten years, been steadily promoting researches of an eminently practical nature. Their expenditure has reached the handsome sum of £1,700, and their proceedings have been enriched with reports on the "Hardening, Tempering, and Annealing of Steel," on the "Form of Riveted Joints," on "Friction at High Velocities," on "Marine Engine Trials," and on the "Value of the Steam-Jacket." The names of those who are acting on these committees are a guarantee that the investigations conducted by them will rank among the classical works of the profession, and will abundantly justify the liberal expenditure which has been incurred.

It is impossible to conclude the address which I have had the honour of delivering without an allusion to the most important structure which engineering skill and enterprise has ever attempted. The Forth Bridge is rapidly approaching completion, and on Saturday, September 14, Mr. Baker is to deliver a lecture, in which, he will, no doubt, tell us when the great work is likely to be completed. I think that the members of this section belong sufficiently to the "working classes" to have a claim to admission to the lecture, and to hear from the lips of the creator of the bridge the story of its inception, of its progress, and his hopes as to its completion.

THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence ; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices :

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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"REFER IT BACK."

"Referred back to the committee." That is the final result of the seeking for tenders for lighting by electricity the wealthiest city of the world. That is right. Ye civic authorities, be filled with admiration of your own importance, and walk softly, ye holders of the purse-strings, for fear of finding yourselves in slippery places. Yea, wait, ye knowing ones, for the time when a few squares of copper and a beaker or two of some acid which you are told will do the trick, and reduce the cost of electric energy utilised for lighting below that of its rival, gas; wait and see, but before you see, you must have resided in another world and your next visit to this mundane sphere must be postponed to the as yet distant millenium.

"Referred back to committee" for what? Will you ask your engineer and your electrician to confer together again, to draw up another specification, to seek other tenders, to analyse these new tenders and report thereon? No doubt such a request will assist to giving further experience to these gentlemen in trying to say the same thing in other words, it may aid printers and pay newspapers, but what is the object of going over all this ground again? Is there one single man among those who vote to "refer back" that believes in the idiotic argument put forward, that somebody had taken out a patent that was to revolutionise electric lighting—and this was to be done with copper and acid somehow. The speaker didn't understand, but he understood well enough to urge it as a plea for procrastination. Just wait and see what time will bring forth, don't be in a hurry—the world of electricity travels fast—we may find ourselves behind the times if we do anything now; yea, let us sit on our marrowbones and watch patiently. Everybody has heard of the man who was always about to begin, yet he lived and died without taking a single step towards the goal he so often talked about. So our City Fathers may be likened to so many Sisyphus' rolling the stone up, and up, and up till just on the brow of the hill the stone overpowers them, and down it rushes to the bottom. But they are not disheartened. Oh, no; they "refer it back" with a light heart, and begin the toil again. What for? Perhaps they hope to emulate Sisyphus in another direction, and gain such experience in "referring back," that they will "refer themselves back" again after they have passed into the shadowless land—not because their wives have failed to perform their funeral rites—but because the matter of electric lighting is not yet settled. There is no understanding the action of the Commissioners from any point of view from which outsiders can look at it. They either intend to do something or they do not. It is to be presumed that the intention is to go forward, or why investigate at all? Why trouble

engineer, electrician, or contractors, if nothing is to be done, and yet how can the "reference back" be reconciled with a desire to obtain more light? Some of the Commissioners seem to think that the City is lighted enough by means of a lot of gas lamps that just make darkness visible, and hamper almost as much as assist in the due execution of work. Time—much valuable time to man and beast is now lost because the City is badly lighted. The giving of a fourfold light at a double the cost would really lead to the saving rather than the spending of money. Work could be carried on much more securely, surely, and quickly, and this is just what cannot be drummed into the heads of men who sit in offices or visit the City from ten to four. They do not and cannot understand that many of them have long ceased to be workers and are mere figureheads, whose room is better than their presence when the question is one of real work.

We have looked in vain into the joint report of the engineer and electrician for any weakness or uncertainty, but cannot find the slightest hint that time will bring improvements, and it may thus be desirable to wait. On the contrary, they are pretty emphatic. "We think that the Streets Committee *can now safely recommend* the Commissioners of Sewers to accept provisionally the tenders of these companies, and to allocate the districts as follow:

"No. 1, West. The Metropolitan Electric Supply Company.

"No. 2, Central. Anglo-American Brush Corporation.

"No. 3, East. London Electric Supply Corporation."

We must confess to being astounded at the result "refer back." The Commissioners employed eminent men to enquire into the matter and to specify what was wanted. They obtained tenders from first-rate companies, whose tenders and suggestions were considered, fully discussed, and brought into line, but in the end this sisyphæan stone has rolled back to its starting place, and we are not one whit nearer the consummation of this lighting than we were last February. The only tangible reason for such a state of things is that some Commissioners have heard something from somebody that someday the cost of electric lighting is to be reduced below that of gas, and that a patent has been taken out for a process which will permit of this. The process indicated, too, is a battery process, at which all electrical engineers will smile, and well they may—but what will they say of the ignorance of Commissioners that permits of such results? We do not expect the Commissioners to be expert electrical engineers, but we do expect them to be sufficiently read, and possessing enough elementary knowledge not to make an exhibition of themselves. If they really are so ignorant, their duty is to take the advice of

the eminent men whose advice has been sought, and not to throw it overboard. If they really think the City is well enough provided with light now, let them say so, and not mislead everybody and spend a lot of money, and cause others to spend large sums, by pottering about a matter they have no intention of pursuing to the end. Surely the City of London expects something better from its representatives than this. If, again, the question is merely one of gas *v.* electric light interest, say so plainly. We are, as a matter of course, and it would hardly be credited if we said, by firm conviction, believers in the necessity for electric lighting, and power distribution. Gas can in no single feature compare with its rival, and we deny that the latter is the more expensive. Ten years after electricity is generally distributed it will be wondered why men did not rush for it, and urge its introduction instead of the selected representatives of modern Babylon "referring the question back to the committee." A quarter of a century after this general distribution our houses will be bolted and barred by means of electricity, it will be our servant morning, noon, and night; it will have become a necessity and no longer a luxury. Our lifts will be raised by its means and our sewing machines driven. The sober carriage horse will have become a piece of electrical apparatus, and altogether as vast a step made in comfort and convenience as has been made within the last thousand years. There is no exaggeration here. A few people understand this, and see that progress on every hand is retarded by the ignorance of those who should be the first to look ahead, and arrive at a thorough understanding of the capabilities of any new agent brought under their notice.

ON A NEW FORM OF CURRENT-WEIGHER.*

BY PROF. JAMES BLYTH, M.A., F.R.S.E.

In the construction of balances for the measurement of electric currents a greater or less difficulty has always been experienced in leading the current into the movable parts of the instrument without seriously interfering with its sensibility. Several methods have been adopted to overcome this difficulty. In some balances the current is led in by mercury cups; in others, flexible leads, made of thin wire spirals or thin metal strips, are employed; while in the recent balances by Sir William Thomson, the difficulty has been overcome by means of his well-known ligature suspension.

Some time ago it occurred to me that still another form of balance might be employed for this purpose, and the present paper is a short description of one which I have made.

The balance referred to is of the ordinary Roberval type, with the pivot connections all replaced by tightly-stretched torsion wires. It is constructed as follows:

On a flat baseboard, Fig. 1, are placed two vertical uprights of wood or other insulating material, about six inches apart. Between these are stretched two parallel wires in the same vertical plane, about three inches apart. To the middle points of these wires are soldered the two horizontal metal bars of the Roberval.

* Paper read before the British Association at Newcastle.

These are about 9 in. long. Both horizontal bars terminate at each end either in forks or rings, placed in a horizontal plane, and wires are tightly stretched between the prongs of the forks, or across a diameter of the rings. To the middle points of these last wires are attached, also by soldering, the vertical bars of the balance, thus completing what takes the place of the ordinary jointed parallelogram of the Roberval.

The vertical bars have metal terminals, insulated from each other, and carry the circular discs, on the rims of which the movable coils of wire are wound. The bars pass at right angles through the centres of the discs, and are fixed to them at their middle points. The fixed coils, which are of exactly the same diameter as the movable ones, are supported from the base-board, and are placed so that one is about $\frac{1}{2}$ in. above one movable coil, while the other is as much below the other movable coil. From this it will be seen that when the balance is in equilibrium the fixed and movable coils are all horizontal, with a space of about $\frac{1}{2}$ in. between each pair.



FIG. 1.

The stretched wires may be either of steel or phosphor bronze, and before being finally soldered are placed under considerable tension.

The current flows through the instrument thus: Entering, say, by the upper wire connecting the fixed supports, it passes to the upper horizontal bar. There it splits into two, one half (supposing the resistances equal) passing to each end of the bar, and, by means of the corresponding fork wires, passing through the movable coils. From the movable coils each half returns along the lower horizontal bar, and together pass out by the lower wire connecting the two main supports. From this the whole current passes first through the one fixed coil and then through the other, and in such a direction as to produce a repulsion between each pair of coils.

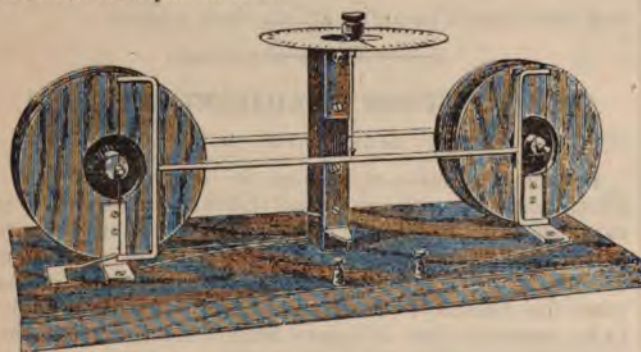


FIG. 2.

In the constructing care is taken that the suspended coils are both made of equal weight, and that when the balance is in equilibrium no torsion is in any of the wires. Small scale pans are attached to each vertical bar, and a bob for raising or lowering the centre of gravity of the whole is placed on a rod springing at right angles from the middle of one of the horizontal bars.

The current strength is estimated by the weight needed to restore the balance to equilibrium when disturbed by the passage of the current. A sliding weight may also be used as in a steelyard.

It will be readily seen that, as in all forms of current-weigher, the weights are proportional to the square of the current strength.

Another form of the instrument, which is in reality a torsion balance, is represented in Fig. 2. It differs

from the previous form in this, that all the coils are in a vertical plane with the torsion wires also vertical, while the current is measured by the number of degrees of torsion that must be given to one end of one of the torsion wires in order to bring the balance to equilibrium. If the connections be considered, it will be seen that no current passes through the wire whose torsion rigidity is used to measure it, and also that the current is so distributed among the other wires that only one-fourth of the heating effect is produced in each of them which would be produced if the entire current went through them. In this way the want of accuracy due to any heating of the wires is reduced to a minimum. The balance exhibited, though only a model, has a resistance of 360 ohms, and is quite sensitive to currents of one-tenth of an ampere.

NEW YORK NOTES.

(FROM OUR SPECIAL CORRESPONDENT.)

A Sensational Week.
Two More Deaths from Electric Shocks.
A Ghastly Sight.
Another Subway Goes Up.
The Board of Electrical Control.
The Vexed Question of Insulation.—Exciting Discussions.
The Mayor Accuses the Expert of Homicide.
A Sweeping Resolution.
The Companies Defy the Board.
Mr. Wheeler on "Dangerous Businesses."—Mr. Wheeler on Testing.
Kemmler to be "Browned."
The Carbon Filament Suit.
Strike at the Edison Lamp Works.

NEW YORK, October 12, 1889.

The week just ending has been a most sensational one as regards electrical matters. Two more deaths resulting from contact with electric light wires have occurred; another subway explosion enlivened affairs in one of the busiest parts of the city; Judge Bradley has decided the carbon filament case in favour of Edison; County Judge Day has declared that the electric execution law is constitutional, and that Kemmler is to be "electrocuted"; and, finally, Mayor Grant threatens to put New York in darkness—as far as the electric light is concerned—by forcing the illuminating companies to shut down until all their circuits are certified as being properly insulated.

On Tuesday last, a lineman in the employ of the Manhattan Electric Light Company, while at work up a pole, received a shock which caused him to lose his hold and fall to the ground; whether he was killed by the shock or the effects of the fall seems to be doubtful, as the injuries he received in falling were sufficient to cause death. The other case referred to occurred yesterday afternoon, and has created a deep sensation, coming immediately after two very stormy meetings of the Board of Electrical Control, and also because it was attended by particularly horrible details and took place in a crowded thoroughfare, in full view of hundreds of people. A Western Union lineman was at work amidst the wires on a tall pole carrying nine cross arms; he had no rubber gloves on, and he completed a circuit by entangling one of his spurs in one wire and grasping another. He lay suspended in the wires for a considerable time before anyone could be got to go up and rescue the body; meantime, the wires resting on his face and neck burned the flesh in a horrible manner, and for fully half an hour this ghastly sight was witnessed by an excited crowd which entirely blocked the street below. This happened at one o'clock in the afternoon, at a spot within about a hundred yards of the City Hall and the approach to the Brooklyn Bridge, which part of New York about corresponds with Cheapside, near the Mansion House, as regards concentration of traffic. The man who was killed was one of a gang who were taking down dead wires, and it is said that the wires on the pole where the accident happened are all telegraph wires, and that they must be crossed with electric light conductors in some other locality. While this accident, on account of the horrors which accompanied it, and because it took place in the presence of so many people, will undoubtedly cause public opinion to uphold Mayor Grant in his aggressive attitude towards the electric lighting companies, it should

be remembered that the linemen themselves are careless in the extreme. The man who was killed yesterday went to work without his rubber gloves and with his arms bared, and, as a general rule, similar disregard of ordinary precautions is one of the features of these accidents.

Last Tuesday a subway explosion occurred at a manhole within a few yards of Telephone Building, the headquarters of most of the telephone companies. The Metropolitan Telephone Company have their principal exchange in this building, and from it radiates their large and rapidly increasing system of underground cables. No damage was done by the explosion to the cables in the subway, but the cover of a manhole was blown off and the pavement started all around; a butcher's cart was just passing over the manhole, and the cart was sent up in the air, the driver, and a boy with him, being thrown to the ground, but neither was seriously hurt.

The Board of Electrical Control held two animated meetings last Wednesday and Thursday, and the Mayor made it very lively for everybody concerned, especially for Mr. Wheeler, the expert to the Board, and for the representatives of the various electric lighting companies. The companies complained that many of the present subways are inadequate, and that the work of construction has gone on slowly; some of them request the privilege of constructing their own subways without expense to the city. The Edison Company lay their own ducts, and it certainly seems unfair that all the companies should not be on an equal footing in this respect.

The President of the Consolidated Subway Company made a long speech in defence of his company, which has the exclusive contract for building all the subways. He said that the electric light companies had not only opposed the subways, but had been tardy in making use of them. The Subway Company had laid 44 miles of conduit the first year, 268 miles the second year, 252 miles the third year, and 175 miles so far in 1889. The representative of a new subway construction company protested against one company having the monopoly of work, and said that, if his company were given a chance, it was ready to put 4,000 men at work the day after the signing of the contract. The Mayor said he would get an opinion from the Corporation counsel on the matter. At the meeting a communication was read from the coroner's office, in which the names of the persons killed by electric shocks during the year were given, and the necessity for removing this source of danger was pointed out. The Mayor said that he took the statements seriously to heart, and felt grieved that the Board had been "presented by the coroner's jury." There was a great deal of talk about insulation, and as to which company's wires are properly insulated and which are not, and, altogether, Mayor Grant can scarcely be blamed if he believes that there is no such thing as insulation—that it is a mockery, a delusion, and a snare. The following is a specimen of the talk that goes on at these meetings.

Mr. Jackson, of the U.S. Illuminating Company, said that his company was particularly anxious to bury all its wires, and wanted a chance to build its own subways. He believed the only safe way was to bury the wires. When asked if an electric light wire could be safely insulated, he evaded a direct answer. He said his company had some properly insulated overhead wires.

"Would you like anybody to touch it?" asked the Mayor. "I would not touch it myself," quietly answered Mr. Jackson, and everybody smiled. Mr. Jackson said that his company had 50 miles of cable underground.

"Well," remarked the Mayor, "I certainly do not want to be held responsible for all these deaths."

One of the commissioners then asked Mr. Jackson: "Are accidents due to the impossibility of safe insulation, to defective insulation, or to overcrowded circuits?"

Mr. Jackson evaded a direct answer, and was finally excused.

Expert Wheeler stated that accidents would not occur if the regulations of the Board were carried out as to insulation.

"Are you not, then, responsible for these deaths?" shouted the Mayor.

"No," insisted Mr. Wheeler.

"I think you are," retorted the Mayor. "You are in a very unenviable position before this Board. The regulations are printed on the back of every permit, and yet you allow the overhead wires to remain."

After much more discussion of a less sensational character, it was resolved to notify the companies "to discontinue the use of such overhead wires as are not properly insulated until such time as said wires shall be certified by the electrical expert of the Board to be in proper and safe condition." It was expected that this notice would have the effect of putting the city in darkness, as the companies would shut down. But no such thing has taken place, and the companies, armed with injunctions to prevent the authorities interfering with their wires, are prepared to defy the Board of Electrical Control and all its myrmidons. The second meeting resulted in a great deal more talk, and absolutely nothing else. Mr. Wheeler read a lengthy report. He said that the only way to ascertain whether the wires are properly insulated or not would be to inspect closely every inch of overhead wire in the City of New York, amounting to 1,000 miles in all, and to do this would require a large force of competent and trustworthy men. Mayor Grant said that to propose inspecting the wires inch by inch for defective insulation was childish. Mr. Wheeler concluded his report by stating that "the business of electric lighting is a dangerous business, much as the railway business and manufacture of illuminating gas, chemicals, and gunpowder. *In the conduct of a dangerous business it is not possible to secure absolute safety except by refraining from that kind of business.* The greatest amount of safety is all that is demanded of those who carry on trades or occupations essentially dangerous to life in their nature. The wires will undoubtedly be safer underground than they can be made overhead, and yet they will still be dangerous. They can be made infinitely safer overhead than they are at present, and still they will be dangerous." The italics in the passage above are my own. It is difficult to see how anyone can conduct a business by "refraining" from it! In a discussion with the Mayor, Mr. Wheeler said, "You can test a wire from the station to determine if it is covered, but you cannot tell that way if the wire is insulated." (!)

"You said yesterday you could find out if the wires were properly insulated," remarked Mayor Grant, rather testily. (Truly the expert to the Board seems to possess about as much "expertness" as some other *soi-disant* electrical experts who are knocking around so plentifully.)

There was some more desultory talk between the representatives of the companies and the Commissioners, and finally one of the latter informed the mayor that the companies would not shut off the current from the overhead wires anyhow. Then there was a pause, until the Mayor remarked, "Well, there's no use in sitting here looking at each other."

Finally the Board adjourned without adopting any fresh resolutions, and leaving matters *in statu quo ante*.

County Judge Day filed his decision in the Kemmler case at Auburn on Wednesday, declaring that the law adopting execution by electricity is not "cruel and unconstitutional," and must take its course. He said, "The questions are, whether the prisoner has overcome the presumption that the statute of 1888 in regard to the infliction of the death penalty provides a cruel and unusual, and therefore unconstitutional punishment, and that a force of electricity sufficient to kill any human subject with celerity and certainty, when scientifically applied, cannot be generated. In my judgment these questions must be answered negatively."

Mr. Cochran, Kemmler's counsel, holds that Judge Day's decision really settles nothing, and he will fight the case to the highest court. He maintains that Kemmler cannot be executed until the final decision is reached.

The decision of Judge Bradley in the incandescent lamp suit between Westinghouse and Edison was filed at Pittsburgh last Saturday. The claims of Sawyer and Mann are dismissed. The decision says in reference to the claimed inventions of Sawyer and Mann: "They may have made a lamp that would burn, but was it a success or was it a failure? Did it ever go into use? What was the object of all the experiments made by them and others? Was it not to make an electric lamp that could be successfully v

by the public, and have a commercial value? Did they succeed in making such a lamp, or in finding out the principle on which it could be made? We do not so read the evidence. The bill must be dismissed."

Mr. Westinghouse says the decision will not affect his company's business, and they will go on making and selling lamps just the same. He hopes for a different decision on appeal. Mr. Edison says that when he saw Judge Bradley, he felt quite safe in going to Europe. He says he has 150 suits pending against Westinghouse, and that they must be settled soon.

There was a strike at the Edison Lamp Works this week, the cause being a reduction of 20 per cent. in the wages; the reason given for the reduction was that the business was poor. The following day the men were taken back at the old salaries.

THE ELECTRIC LIGHTING OF THE CITY.

In our issue of April 19 we gave a specification of the conditions for supplying the City of London with electricity, and a map showing the three districts into which the City was divided for the purposes of this tender. The following information must be read in connection with the specification, so as to be fully understood. Five different companies sent in tenders—viz., the Brush, the London Electric Supply Corporation, the Metropolitan Electric Supply Company, the House-to-House Electric Supply Company, and Messrs. Laing, Wharton, and Down. The Streets Committee of the Commission of Sewers of the City of London obtained, not only these tenders, but reports from their engineer, Mr. Haywood, and from their electrician, Mr. W. H. Preece, who also went carefully into the various tenders, and commented upon the clauses and the modifications which those who tendered desired to incorporate upon the original specification. These comments we give herewith. The numbers refer to the clauses of the specification, which can be found in our issue as previously mentioned, thus:

Clause 4.—*Re-description of Lamps, etc.*

4. The London Electric Supply Corporation. Arc lamps, 500 watts; glow lamps, 100 watts; of the description most suitable to their respective purposes, and the best procurable at the time of installation.

The Metropolitan Company do not specify.—This company (amended conditions) specify 2,000-c.p. arc lamps, taking 10 amperes of current. Energy required 500 watts per lamp.

The Anglo-American Brush Corporation.—(a.) Arc lamps: Brush double carbon lamps, taking a current of 10 amperes at 50 volts; energy required for each lamp, 500 watts; candle-power, 2,000 nominal. (b.) Glow lamps, for principal narrow streets, to be worked in series with the arc lamps. Current, 10 amperes (20 volts); energy per lamp, 200 watts; candle-power, 64 actual. (c.) Glow lamps, for ordinary narrow streets, lanes, and courts, to be worked in series with the arc lamps. Current, 10 amperes (10 volts); energy per lamp, 100 watts; candle-power, 32 actual.

The House-to-House Electric Light Supply Company.—Lamps are to be focussing arc lamps, suitable for alternating currents, each lamp consuming 500 watts, and giving a nominal light of 2,000 c.p.; or, at the choice of the Commission, lamps of 280 watts, and 1,000 n.c.p. All the lamps to be run on parallel from two separate circuits, each alternate lamp being on a different circuit. No other than street lighting to be done from these circuits.

Messrs. Laing, Wharton, and Down.—Thomson-Houston arc lamps of 2,000 c.p. nominal, absorbing 500 watts each, with current of 10 amperes. Not proposed to use glow lamps in main streets; side streets and courts to be lighted with glow lamps in series of 32 and 64 c.p.

Clause 5.—*Situation of Generating Stations.*

5. The Anglo-American Brush Corporation's generating station is outside the City; conductors to enter by the thoroughfares on the north and bridges on the south.

The London Electric Supply Corporation's generating station is at Deptford. Main conductors would enter City † Cannon-street and Blackfriars Bridges.

Metropolitan Electric Supply Company do not state where station is to be, or where conductors are to enter the City; but by subsequent letter they propose to place a station at Greenore Wharf, near Blackfriars Bridge, on the Surrey side of the river, and also one at Sardinia-street, Lincoln's-inn-fields. The Metropolitan Electric Supply Company (amended condition) say: "The situation of the generating station will be Greenore Wharf, and the mains will enter the city by Southwark and Blackfriars Bridges."

The House-to-House Company do not state where station is to be, or indicate where conductors are to enter the city.

Messrs. Laing, Wharton, and Down state that it is not contemplated to erect the generating station within the City. Conductors to enter at Aldgate, Fenchurch-street, and Cannon-street Station.

Clause 7.—*System to be Adopted.*

7. The high-pressure alternate-current system will be used by the London Electric Supply Corporation, the Metropolitan Electric Supply Company, and the House-to-House Electric Supply Company.

The high-pressure direct system for public lighting will be used by the Anglo-American Brush Corporation and Messrs. Laing, Wharton, and Down. The Metropolitan Electric Supply Company (amended conditions) also propose to use this system for their arc lamp circuits.

The direct-current battery system for private lighting will be used by the Anglo-American Brush Corporation.

Clause 9.—*Date of Lighting.*

9. The Anglo-American Brush Corporation.—Main thoroughfares to be commenced within three months of signing contract, and completed in 15 months. Other streets to be commenced as soon as possible after main thoroughfares have been completed. Lighting to be put in operation at the rate of 50 lamps every three months, the whole to be finished in three years from signing contract.

The London Electric Supply Corporation.—As soon as possible after statutory powers are granted.

Metropolitan Electric Supply Company.—All distributing mains and boxes to be laid within eighteen months of confirmation of agreement.

The House-to-House Company.—Public lighting of main streets to commence within three months of signing contract, and be completed within twelve months. Other portions of district to be lighted within nine months of instruction to commence and authorisation to lay mains in streets.

Messrs. Laing, Wharton, and Down commence within three months of signing contract, and main streets to be lighted within fifteen months. Other parts of district to be started as soon as 50 lamps are ready, and added to by 50 at a time. The whole district to be lighted within three years from signing contract.

Clause 10.—*Price.*

10. The Anglo-American Brush Corporation.—Arc lamps, £30 per annum; glow lamps (200 watts) £13 per annum; glow lamps (100 watts) £7 per annum. These prices to be reduced to £26, £10, and £5 respectively, if certain modifications in clause 33 of specification are granted.

The London Electric Supply Corporation.—Supply to be by meter, at 3s. 6d. per unit of 10,000 watts, including maintenance. (The usual unit is 1,000 watts, and the price is therefore 4.2d. per Board of Trade unit). This corporation, in their amended tender, make the following modification: "This corporation will undertake to light the 136 lamps during the hours specified in the enclosed tables—namely, for 3,810 hours per lamp annually for the 68 lamps running throughout the night, and for 1,997 hours per lamp annually for those running till midnight—* for the sum of £24. 3s. 10d. per lamp per annum over the whole of the 136 lamps; and for lamps running for other hours than those specified in the enclosed tables at the rate of £1. 2s. 8d. per hour on the whole of the 136 lamps, or a proportionate sum for a less number." Light required on foggy or dark days will have to be paid for as set forth in the latter part of the above clause.

* The company have since waived the condition as to extinguishing half the lamps at midnight, increasing the price to £26 per lamp.

The Metropolitan Electric Supply Company.—6s. 8d. per unit of 10,000 amperes, which is equivalent to 8d. per Board of Trade unit. This is for private lighting, but by a subsequent letter the price for public lighting is tendered for at 3d. per unit. This company's amended tender quotes £30 as the annual charge for each arc lamp, to be reduced to £26 if certain modifications suggested are agreed upon.

The House-to-House Company.—

	Candle power.	Per annum.	Watts.	£	s.	d.
Arc lamps	2,000	500	45	0	0	
"	1,000	280	25	0	0	
Glow lamps	200	500	45	0	0	
"	100	250	22	10	0	
"	50	150	14	0	0	
"	16	50	4	10	0	

Messrs. Laing, Wharton, and Down.—

	Candle power.	Per annum.	£	s.	d.	Hours.
Arc lamps	2,000	30	0	0	0	3,750
Glow lamps	64	12	0	0	0	"
"	32	7	0	0	0	"

Extra hours in proportion. These prices to be reduced to £26, £10 and £5 respectively, if certain modifications in clause 33 of specification are granted.

Clause 11.—Hours during which Lamps are Lighted.

11. Agreed to by all. The London Electric Supply Corporation's proposed (amended tender) to put out half the lights at midnight, is fully set forth in a note to clause 10. (The condition as to extinguishing half the lamps at midnight has since been waived.)

Clause 25.—Time for Completion of Work.

25. The Anglo-American Brush Corporation.—Main thoroughfares to be commenced within three months of signing contract, and completed in 15 months. Other streets to be commenced as soon as possible after main thoroughfares have been completed, lighting to be put in operation at the rate of 50 lamps every three months, the whole to be finished in three years from signing contract.

The London Electric Supply Corporation say they will commence as soon as possible after receipt of statutory powers, and complete as early as circumstances will permit.

The Metropolitan Electric Supply Company.—All distributing mains and boxes to be laid within 18 months of confirmation of agreement. This company (amended conditions) undertake to begin within six months of signing contract, and complete in main thoroughfares within 18 months of commencement; but these periods are not to begin to run until they are authorised to proceed with the work by license, order, or Bill.

The House-to-House Company.—Public lighting, main streets, to commence within three months of signing contract, and completed within 12 months. Other streets within nine months of instruction to commence and authorisation to lay mains. They propose to insert the words "except through causes beyond their control," after the word "interruption," on line 7.

Messrs. Laing, Wharton, and Down.—Commence within three months of signing contract. Main streets to be lighted within 15 months. The whole district within three years from signing contract.

Clause 29.—How Current is to be Charged.

29. The Anglo-American Brush Corporation.—(a) By meter. (b) Rate 8d. per unit of 1,000 watts. Consumer to pay for a minimum consumption of 50 units per annum on each ampere capacity of his meter.

The London Electric Supply Corporation say in this respect they will be governed by the terms of their provisional order and Board of Trade regulations. Their general system of supply will be by meter, but they do not absolutely confine themselves to this.

The Metropolitan Electric Supply Company.—By meter, at 8d. per unit. By agreement, 30s. per annum per lamp for a continuous supply, or 25s. for an intermittent supply during 18 hours per day. This company (amended conditions) propose that this clause shall read as follows: "So far as the Commission are able to do so, they will grant to the contractor the exclusive

right of supplying electricity for public and private purposes, as defined by the Electric Lighting Act, 1882, within the district during the term of the contract. The contractor will be required to supply electricity to any owner or occupier of any premises within a distance of 25 yards of any main in which the contractor is bound to maintain a supply of electricity for general purposes, provided the owner or occupier enters into a fair agreement to defray or divide the cost of the service main, and to pay for the supply of the electricity, and, if required by the contractor, to give security for such payment. The contractor can charge the consumer for the amount of electricity supplied either—(1) by meter or (2) by agreement," etc., etc.

Messrs. Laing, Wharton, and Down.—By meter at 8d. per Board of Trade unit, or by agreement based upon above price.

The House-to-House Company.—By meter, quarterly, on sliding scale, varying with maximum supply as follows: 1. At the rate of 1s. per Board of Trade unit of 1,000 watt hours for the first 100 hours' consumption of maximum supply. 2. At 8d. per Board of Trade unit for the second 100 hours. 3. At 4d. per Board of Trade unit for any further quantity consumed.

Clause 30.—Determination of Contract.

The Metropolitan Electric Supply Company (amended conditions) propose that this clause shall read as follows: "At the expiration or determination of the contract for the supply of electricity for public lighting, the contractor is to have the right to continue to supply electricity for private purposes within the district, and for public purposes as defined by the Electric Lighting Acts, other than street lighting, and to enjoy free way-leave, so far as the Commission are able to grant it for these purposes, subject to the conditions for regulating the laying of mains and other works, and provided the contract has not been determined by the Commission for the following reasons: (1) Under the 26th or 39th clauses (2) In consequence of the contractor ceasing to supply electricity for private purposes for a continuous period of one month to any consumer who has complied with the conditions of the 29th clause, and has not committed any act or failed to do anything which would justify the contractor in discontinuing such supply."

The Metropolitan Electric Supply Company (amended conditions) insert a new clause—30A—as follows: "If the owner or occupier of any premises supplied uses any form of lamp or burner, or uses the energy supplied to him by the contractor for any purposes, or deals with it in any manner so as to unduly or improperly interfere with the efficient supply of energy, to any other body or person by the contractor, the contractor may, if he think fit, discontinue to supply energy to such premises so long as such user continues. The contractor shall not be compelled to give a supply of energy to any premises unless he is reasonably satisfied that the electric lines, fittings, and works therein are in good order and condition, and not calculated to affect injuriously the use of energy by the contractor, or by other persons. If any difference arise under this clause as to any improper use of energy, or as to any alleged defect in any electric lines, fittings, or works, such difference shall be determined by arbitration."

Clause 31.—Test of Mains.

31. The London Electric Supply Corporation propose to substitute the terms of their provisional order on this point. Other companies pass without comment.

The Metropolitan Electric Supply Company (amended conditions) alter this clause as follows: "The Commission may at all reasonable times, whilst the contract is in force, test the condition and efficiency of the mains and conductors for insulation and conductivity, in such manner and at such times as they deem desirable, and the contractor shall afford every reasonable facility for this purpose, and shall provide sufficient testing-places, and sufficient testing conveniences, and shall repair any defect that may be detected within a reasonable period, in default of which a penalty of £20 per day will be exacted so long as the defect continues. The contractor shall not be held responsible for any interruption in the supply of energy which may be occasioned by any such testing. If any question arise under this clause, the same shall be referred to arbitration."

May, 1889.

CITY ELECTRIC LIGHTING.—ABSTRACT OF TENDERS.

Name of company tendering.	Districts tendered for.	Arc lamps.		Glow lamps.		Main streets.		Other thoroughfares.		Supply of current for private lighting, etc.	Systems proposed to be used.
		Candle-power.	Annual cost (each).	Candle-power.	Annual cost (each).	Work commenced.	Work completed.	Work commenced.	Work completed.		
Anglo-American Corporation	Nos. 1 and 2	(a) 2,000 nominal Or (see note*)	£ s. d. 30 0 0 26 0 0	(b) 64 actual (200 watts) (c) 32 actual (100 watts)	£ s. d. 13 0 0 7 0 0	Within 3 months of signing contract.	In 15 months from commencement of work.	As soon as possible after main streets are completed.	Whole work to be completed in 3 years from signing contract.	By meter, at 8d. per Board of Trade unit.	Brush series system. Current 10 amperes. Arc lamps take 50 volts; glow lamps (b), 20 volts; and glow lamps (c), 10 volts. * N.B.—In case of suggested alteration to clause 33, annual cost will be reduced to: Arc lamps, £26; glow lamps (b), £10; and (c), £5.
London Electric Supply Corporation	Nos. 1, 2 & 3	(500 watts) (see note)	37 12 6	(100 watts)	7 10 6	Soon as possible after statutory powers are granted.				(1) By meter: Up to 150 units, per quarter, £5; beyond, 8d. per unit. (2) By agreement.	Alternating current, with transformers. * N.B.—This company proposes to charge the Commissioners at the rate of 4½d. per unit for current for public lighting, which is equivalent to £37. 12s. 6d. per annum per arc lamp of 500 watts.
Metropolitan Electric Supply Company	No. 1	No particulars given, but a 500-watt lamp at 3d. per unit would cost £26. 17s. 6d. per annum. Amended tender gives £30 per annum as cost per arc lamp, to be reduced to £26 if proposed modifications are accepted. Arc lamps of 2,000 c.p. nominal will be used.				Within 6 months of signing contract and obtaining provisional order.	Within 2 years of signing contract and obtaining provisional order.			(1) By meter, at 8d. per unit. (2) By agreement, 30s. on the basis of their agreement with the Strand District per annum per lamp, for Board of Works. Cost of current would apparently be the same for public as for private lighting. A 25s. for an intermittent subsequent letter names 3d. per unit as the price for supply during 18 hours public lighting per day.	This company proposes to charge the Commissioners on the basis of their agreement with the Strand District per annum per lamp, for Board of Works. Cost of current would apparently be the same for public as for private lighting. A 25s. for an intermittent subsequent letter names 3d. per unit as the price for supply during 18 hours public lighting per day.
Laing, Wharton, and Down	No. 3	2,000 nominal Or (see note*)	30 0 0 26 0 0	64 32	12 0 0 7 0 0	Within 3 months of signing contract.	Within 18 months from signing contract.			(1) By meter at 8d. per Board of Trade unit. (2) By agreement.	Thomson-Houston system. Arc lamps only to be used for scheduled streets, arc and glow combined for other thoroughfares. Prices are for a year of 3,750 hours. Extra hours will be in proportion. * N.B.—In case of suggested alterations to clause 33, prices will be reduced to £26 for arc lamps, and glow lamps will be reduced in proportion.
House-to-House Electric Light Company	No. 3 (or either)	2,000 nominal 1,000 "	45 0 0 25 0 0	200 100 50 16	45 0 0 22 10 0 14 0 0 4 10 0	3 months after date of contract.	In 12 months.	Work to be completed within 9 months of receipt of instructions to commence the work.		By meter, quarterly, on a sliding scale, 1s. 8d. lamp being fed from a separate converter, and 4d. per unit.	Alternating-current parallel-converter system, every lamp being fed from a separate converter. WILLIAM HAYWOOD, W. H. PREECE.

STATEMENT SHOWING NUMBER OF ELECTRIC LAMPS IN EACH DISTRICT, AS PROPOSED BY THE CONTRACTORS TENDERING.

District.	Name of company tendering.	Arc lamps.			Glow lamps.		
		On new standards.	On existing supports.	Total.	On new standards.	On existing supports.	Total.
No. 1 (West)	Anglo-American Brush, etc., Corporation ...	110	11	121	106	188	294
	London Electric Supply Corporation	not	stated.	Supply	to be by	meter.	
No. 2 (Central) ...	Metropolitan Electric Company	138	—	138	108	204	312
	Anglo-American Brush, etc., Corporation ...	not	stated.	Supply	to be by	meter.	
No. 3 (East)	London Electric Supply Corporation	227	6	233	125	182	307
	Laing, Wharton, and Down	135	—	135	—	—	—
	House-to-House Company	not	stated.	Supply	to be by	meter.	
	London Electric Supply Corporation						

NOTE.—Public lamps are alight 4,300 hours per annum. A good arc lamp consumes 500 watts, therefore each arc lamp consumes 2,150,000 watt hours, or 2,150 Board of Trade units per annum. Hence—

8d. per unit = £71 3 4 per ann. | 6d. per unit = £53 15 0 per ann. | 4d. per unit = £35 16 8 per ann. | WILLIAM HAYWOOD.
7d. „ = 62 14 2 „ | 5d. „ = 44 15 10 „ | 3d. „ = 26 17 6 „ | W. H. PREECE.

Clause 33.—Penalties.

33. The Anglo-American Brush Corporation wish to modify this clause so that the penalty shall be 1d. per minute per lamp, with maximum of 5s. per lamp per night. No penalty to be incurred within 15 minutes of lighting up.

The House-to-House Company propose to insert the words “per diem.” They also suggest (see clause at end of specification) that aggregate penalties for one day shall not exceed £50, and that no penalty at all shall be inflicted where failure was due to causes beyond their control, or where failure was so slight as not to affect materially the value of the supply.

Laing, Wharton, and Down propose a “sliding scale” of fines—i.e., 1d. per lamp per minute, with a maximum of 5s. per lamp per night.

The London Electric Supply Corporation will pay for substituted (gas) lighting “so far only as attendance to the gas lamps is concerned. . . . The penalties for failure are provided in the provisional order applied for by them.”

The Metropolitan Company make no comment.—This company (amended conditions) strike out the words “forty shillings” in line nine, and insert the words “one penny per minute.” And after the words “five minutes” in line 12 they insert the words “and occurring after 15 minutes have expired from the first lighting of the lamps.” At the end of the clause they add the words: “But such penalty shall not in any case exceed 5s. per lamp per 24 hours.

Clause 40.—Acquiring the Undertaking.

40. The House-to-House Company propose to strike out the words “in accordance with section 2 of the Electric Lighting Act, 1888,” and to substitute the words “the purchase shall be carried out on the basis of usual commercial terms to be settled by arbitration as hereinbefore provided, failing agreement.” (See proposed clause 42E, at end of specification.)

The London Electric Supply Corporation cannot accept any clause to this effect, and will not make any agreement as to compulsory powers of purchase other than provided in the Electric Lighting Acts. Other companies pass without comment.

The Metropolitan Electric Supply Company (amended condition) propose that this clause shall read as follows: “Power is to be reserved to the Commission to acquire the undertaking and works, by purchase, at the time or times and in the manner specified in section 2 of the Electric Lighting Act, 1888.”

Proposed Additional Clauses.

The House-to-House Company propose the following clauses:

Clause 42A.—All differences or disputes which may arise between the contractor on the one hand, and the Commission, or their engineer on the other, whether as to the construction or meaning of this tender, or the contract to be hereafter executed in pursuance therewith, or as to any of the conditions, obligations, and provisions of the said tender or contract, or anything to be done, observed, or performed thereunder, shall be referred to arbitration in the usual way, except that a sole arbitrator shall be nominated by the

President for the time being of the Board of Trade, at the request of either party, and such arbitrator shall decide on all questions in dispute, and may give costs of the reference to either party. This decision shall be binding and final on all parties, and this submission to arbitration and the arbitrator's award, or either of them, may be made a rule of either division of the High Court of Justice by either party.

Clause 42B.—The following addendum shall be made to clause 33: “Provided that the penalties to be inflicted on the contractor under this section shall in no case exceed in the aggregate the sum of £50 in respect of any defaults or failure in any one day: Provided also that in no case shall any penalties be inflicted in respect of any default or failure if occasioned by inevitable accident, or by *force majeure*, or was of so slight or unimportant a character as not materially to affect the value of the supply, or where such default or failure was not wilful or due to any negligence on the part of the contractor, its officers or servants, and all reasonable precautions have been taken by it to prevent the occurrence of such default or failure.”

Clause 42C.—Clause 30 shall be modified as follows: “The contractor is to have the right to continue to supply electricity for private purposes within the district for a period of 42 years from the date of the contract, subject to the provisions as to the alteration and variation of price hereinbefore contained, and to the provision as to determination thereof hereinafter expressed. And the Commission may have and exercise the same powers as they would have had under section 2 of ‘The Electric Lighting Act, 1888,’ of requiring the contractor to sell the undertaking, if the works referred to in this contract had been an undertaking within the meaning of that section, and if required by the contractor, the Commission will apply for leave to introduce or join the contractor in an application to introduce a Bill into Parliament to confirm this contract; which Bill may contain further provisions as to the appointment of electric inspectors, and as to meters and testing similar in substance to those which may be contained in the provisional orders which may be sanctioned by the Board of Trade this year, and for providing and recovering penalties from the contractors for failure to supply, and for breach of the provisions of this contract. The contractors are not to otherwise promote any provisional order or Bill affecting the City of London, any of the terms or provisions of which shall be inconsistent with the contract.” Except, as hereby modified, clause 30 shall stand with the addition shown in red ink.

Clause 42D.—In lieu of clause 39 there shall be read: “And it is hereby further agreed that if at any time the Commission is of opinion that the contractor has either failed to commence any works which he ought to have commenced under the provisions of this agreement, or has discontinued to effectively carry on such works, or to supply electricity efficiently throughout the district, in accordance with the true spirit and intent of this agreement, such default or discontinuance not being caused by inevitable accident, *force majeure*, or circumstances beyond the control of the contractor (want of funds not being deemed to be such a

circumstance), the Commission may apply to the Board of Trade (after notice to the contractor) to appoint an independent person to enquire into the facts of such representations, and if upon such enquiry such person is satisfied of the truth thereof, and shall so report to the Board of Trade in writing under his hand, the Commission may, by special resolution under their seal, revoke and determine this contract as from a date to be specified in such resolution, and this contract shall thereupon cease, and determine accordingly, and the contractor shall forthwith remove all his mains, lines, boxes, and works from the streets and public thoroughfares within the district, and in the event of their not being so removed the Commission may remove them, and all the costs and expenses of, and incidental to, such removal, and the reinstatement and repair for a period of 12 months thereafter of any streets, footpaths, kerbs, channels, sewers, drains, or other works disturbed in the process, shall be paid by the contractor to the Commission, and may be recovered in a summary way from the contractor by the Commission."

Clause 42E.—In lieu of the words "in accordance with section 2 of the Electric Lighting Act, 1888," in clause 40 herein, there shall be read "the purchase shall be carried out on the basis of usual commercial terms to be settled by arbitration, as hereinbefore provided, failing agreement."

It is proposed to instal 136 arc lamps for lighting the public streets, one-half of which are to be alight from dusk to dawn, and the other half from dusk till midnight.

The following table gives the hours when artificial light is needed throughout the year, and is compiled from the statistics of street lighting by gas in the metropolis:

			Hours of		
Days.			Light up Turn out lighting		per night
			P.M.	A.M.	
January...	First ...	10 ...	4.30	7.30	15
	Second...	10 ...	4.30	7.30	15
	Last ...	11 ...	5.0	7.0	14
February	First ...	10 ...	5.30	6.45	13½
	Second...	10 ...	5.30	6.30	13
	Last ...	8 ...	6.0	6.0	12
March ...	First ...	10 ...	6.0	5.30	11½
	Second...	10 ...	6.30	5.0	10¾
	Last ...	11 ...	6.45	4.30	9¾
April	First ...	10 ...	7.0	4.0	9
	Second...	10 ...	7.30	4.0	8½
	Last ...	10 ...	7.45	3.30	7¾
May	First ...	10 ...	8.15	3.0	6¾
	Second...	10 ...	8.30	2.45	6¼
	Last ...	11 ...	8.45	2.30	5¾
June.....	First ...	10 ...	8.45	2.30	5¾
	Second...	10 ...	9.0	2.30	5½
	Last ...	10 ...	9.0	2.30	5½
July.....	First ...	10 ...	9.0	2.45	5¾
	Second...	10 ...	8.45	3.0	6¼
	Last ...	11 ...	8.30	3.0	6¾
August...	First ...	10 ...	8.0	3.30	7½
	Second...	10 ...	7.45	3.30	7¾
	Last ...	11 ...	7.30	4.15	8¾
September	First ...	10 ...	7.0	4.30	9½
	Second...	10 ...	6.30	4.45	10¼
	Last ...	10 ...	6.0	5.0	11
October	First ...	10 ...	5.30	5.15	11¾
	Second...	10 ...	5.0	6.0	13
	Last ...	11 ...	4.45	6.15	13½
November	First ...	10 ...	4.30	6.45	14¼
	Second...	10 ...	4.30	7.0	14½
	Last ...	10 ...	4.15	7.30	15¼
December	First ...	10 ...	4.15	7.30	15¼
	Second...	10 ...	4.15	7.30	15¼
	Last ...	11 ...	4.15	7.30	15¼

The above is exclusive of light required on foggy and dark days.

The lamps running all night, from dusk to dawn, will average rather less than 10½ hours per diem throughout the year. The lamps running from dusk to midnight will average rather less than 5½ hours per diem throughout the year. One lamp with another, the average over the whole will be rather less than 8 hours per diem throughout the year. The hours per lamp running from dusk to dawn will be as follows

	Days.	Hours.	Total lamp hours
January	10	15	150
	10	15	150
	11	14	154
February	10	13½	132½
	10	13	130
	8	12	96
March	10	11½	115
	10	10½	105
	11	9½	107½
April	10	9	90
	10	8½	85
	10	7½	77½
May	10	6½	67½
	10	6½	62½
	11	5½	63½
June	10	5½	57½
	10	5½	55
	10	5½	55
July	10	5½	57½
	10	6½	62½
	11	6½	71½
August	10	7½	75
	10	7½	77½
	11	8½	96¼
September ...	10	9½	95
	10	10½	102½
	10	11	110
October	10	11½	117½
	10	13	130
	11	13½	148½
November	10	14½	142½
	10	14½	145
	10	15½	152½
December	10	15½	152½
	10	15½	152½
	11	15½	167¾

Total 3,809½

The hours per lamp running from dusk to midnight will be as follows:

	Days.	Hours.	Total lamp hours
January	10	7½	75
	10	7½	75
	11	7	77
February	10	6½	65
	10	6½	65
	8	6	48
March	10	6	60
	10	5½	55
	11	5½	67¼
April	10	5	50
	10	4½	45
	10	4½	42½
May	10	3¾	37½
	10	3½	35
	11	3½	35¼
June	10	3½	32½
	10	3	30
	10	3	30
July	10	3	30
	10	3½	32½
	11	3½	38½
August	10	4	40
	10	4½	42½
	11	4½	49½
September ...	10	5	50
	10	5½	55
	10	6	60
October	10	6½	65
	10	7	70
	11	7½	79¼
November	10	7½	75
	10	7½	75
	10	7	77½
December	10	7	77½
	10	7	77½
	11	7½	85¼

Total 1,996½

SUMMARY.

	Lamp hours.
68 lamps from dusk to dawn	259,046
68 lamps from dusk to midnight.....	135,762
Grand total	394,808 per annum.

Taking one lamp with another, the charge per lamp per annum will work out to £24. 3s. 10d. for the ordinary night lighting, as against £26, which is understood to be the tender price of the Brush Corporation.

In our computation there is, therefore, a margin of £1. 16s. 2d. per lamp per annum for fogs and dark days, of which no account has been taken in the previous calculations. This is equivalent to the running of 68 lamps for 434 additional hours during the year, which is considered an adequate provision for dark and foggy days.

This tender is intended to cover everything in the way of carbons, maintenance, and attendance, and is, in fact, an inclusive charge.

CHARLES B. WALLER, Manager and Secretary.

THE BIRMINGHAM ELECTRICAL AND INDUSTRIAL EXHIBITION.

EXHIBITORS' AWARDS.

FIRST CLASS GOLD MEDALS.—ELECTRICAL SECTION.

Class I. : Lighting and Power.—Anglo-American Brush Corporation, London, alternating-current dynamos and transformers, lighting, and general exhibit; Buller, Jobson, and Co., Dudley, insulators; Crompton and Co., London, electric cranes and incandescent lighting dynamos; Elwell-Parker, Limited, Wolverhampton, accumulators and incandescent lighting; Edison and Swan Company, London, incandescent lamps; A. A. Goldston, Middlesbrough, series arc and incandescent lighting and exhibit; Lacombe and Co., London, electric light carbons; Laurence, Paris, and Scott, Norwich, dynamos and motors.

Class II. : General.—W. and T. Avery, Birmingham, electric weighing machine and bells; Fowler, Lancaster, and Co., Birmingham, electrical fittings in china; Tullis and Son, Glasgow, orange, tan, and link belting.

FIRST CLASS SILVER MEDALS.

Class I. : Lighting and Power.—Acme Electric Works, London, electric fitting for electric lighting; Appleton, Burbey, and Williamson, London, main switches and general exhibit; Electrical Power Storage Company, London, storage cells and instruments; J. Fowler and Co., Leeds, lead-covered cables; Glover and Co., Salford, wires and cables (lighting and telephonic); Henley's Telegraphic Company, London, submarine wires and cables; Immisch and Co., London, motors; Muller, London, instruments and carbons; Scott and Co., Newcastle-on-Tyne, parallel arc lighting; Statter and Co., London, constant-current dynamos and general exhibit; Woodhouse and Rawson, London, electrical apparatus for lighting; Campbell Gas-Engine Company, Halifax, gas-engine.

Class II. : General.—Canning and Co., Birmingham, electroplating; Davis and Sons, Derby, outdoor electric-light fittings; General Electric Company, London, general exhibit; W. Middlemore, Birmingham, belting; Nalder Bros., London, electrical instruments; National Telephone Company, Birmingham, improvements in telephone apparatus; Piercy and Co., Birmingham, Griffin gas-engine; Julius Sax, London, electrical fire alarm.

FIRST CLASS BRONZE MEDALS.

Electrical Section: General.—T. Coad, London, primary batteries; C. Conradty, London, carbons; Hartley and Co., Birmingham, electroplating; Myatt and Pullinger, Birmingham, electroplating; Mayfield and Co., London, Wimshurst electrical machine.

SPECIAL AWARDS.

Gold Medals.—Galloways, Limited, Manchester, boilers; Greenwood and Batley, Limited, Leeds, high-speed Armington-Sims engine; Robey and Co., Lincoln, small high-speed engines; Ruston, Proctor, and Co., Lincoln, compound engines; Thomson-Houston, London, electric arc lighting system.

Consolidated Telephone Construction and Maintenance Company, Limited.—The Directors of the Company have declared an interim dividend for the half-year at the rate of 5 per cent. per annum, less income-tax, on the ordinary, and at the rate of 6 per cent. per annum, less income-tax, on the preference shares, the respective dividends to be payable on November 14.

CORRESPONDENCE.

OLD STUDENTS' DINNER.

TO THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—Your last issue contains a report of a speech I am supposed to have made at the Old Students' Association. I am quite sure that there was no intention on the part of the reporter to misrepresent what I said, but the report is evidently compiled from imperfect notes. I never mentioned the Brush Company, and I never stated anything about a roof of 200ft. span. If errors like this have crept in, perhaps your readers may credit also that the reporter has given unintentionally a wrong bias to what I said, and has put into my mouth cant phrases such as that about the "advantages of technical training," which I abominate so much that I am sure I never use them. On such an occasion I feel not a little responsibility, and I express myself quite carefully. Perhaps your readers will therefore pardon me for withdrawing from any responsibility for statements attributed to me with the speech as reported.—Yours, etc.,

W. C. UNWIN.

Kensington, October 19.

COMPANIES' MEETINGS.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.

The thirty-second ordinary general meeting of the Eastern Extension, Australasia, and China Telegraph Company, Limited, was held on Wednesday at Winchester House, Old Broad-street, Sir John Pender presiding.

The **Chairman** stated that the gross receipts for the half-year ended June 30 last had been £256,757, or £16,831 in excess of those for the corresponding period of 1888, due to the general growth of business all over their system. Their working expenses for the same period had been £73,773, or an increase of £4,476, principally owing to the opening of their station at Roebuck Bay, in connection with the Western Australian cable, and the construction of a new pipe land line between the cable-house and offices at Madras, to replace the old one which had been down for about ten years. Their net revenue had been £138,736, or £12,932 more than for the June half of 1888. Interim dividends at the rate of 5 per cent. per annum had been paid for the half-year, leaving £26,236 to be carried forward, after debiting revenue with £50,000 on account of the Western Australian cable. The shareholders would remember that when their two cables to Australia were interrupted, greatly owing to volcanic action, they decided without delay to put down an additional cable to Australia, in order to give them perfect security and continuity in their connections with the colonies. That cable cost them a large sum of money, but it did not bring them in any more traffic. It was practically a reserve, and since the cable had been laid they had had good reason to congratulate themselves on the fact. There had been certain interruptions in the land lines in Australia, and but for the cable in question their traffic would have been seriously interrupted. It had been the policy of the Directors to keep down the capital as much as possible, and, taking a broad view of the matter, they had written £50,000 off the cost of the cable out of the past half-year's revenue. With regard to the balance of the cost, the way in which they would deal with it would depend largely on the progress and prosperity of their system in the next six months. Since this half-year began they had had an important interruption in their New Zealand cable, which had greatly interfered with that part of their traffic. Feeling that the work of that cable was increasing, that it had been down for 14 years, and that the time must soon come when they would have to duplicate it, they thought that the sooner they did the work the better. They had accordingly sent a telegram to the Government of New Zealand proposing to duplicate this cable on certain terms, and he hoped that before the expiration of a week they might be able to go on with the work. All their cables were that day in good working order. A good deal had been said about a Pacific cable—a line the object of which would be more to reduce their rates than to give increased facilities. The present cable of the Company could do considerably more work than was brought to it at present, but if the colonial Governments or our own Government determined for strategical purposes that a Pacific line should be laid, the Company were quite prepared to carry out the work if they were properly remunerated. The line to New Zealand which they now proposed to duplicate would be what might be called the first link in the Pacific cable. Other work was very likely to be done in connection with their system. The French had New Caledonia, and he believed that that would eventually have to be dealt with. British North Borneo would also want a cable. They were now in negotiation with Spain for extending their system to the Philippine Islands. They must be prepared to meet all these requirements, but with due regard to the interest of the shareholders. Their 6 per cent. debentures would expire in 1891, when they would be dealt with in a way which

would be satisfactory to the shareholders. They also had a large number of debentures guaranteed by the Australian Government subsidy, but they were being, he might say, written off, and by the time the subsidy expired these debentures would be extinguished. In the past six months they had renewed about 132 knots of cable, at a cost of about £8,000, and in the current six months they would carry out renewals to a similar extent, and thus nearly complete the renewals which they at present had in view. They were in that way, too, strengthening their position. The Directors were glad to be able to present them with a satisfactory dividend—a dividend which he hoped would be added to at their next meeting by a handsome bonus. He concluded by proposing the adoption of the report.

Mr. F. A. Bevan seconded the motion.

Mr. Lewis stated that the Company had, on the one hand, about £700,000 invested as reserve funds, the securities returning them about 3 or 4 per cent.; while, on the other hand, they had £320,000 of debentures on which they were paying 6 per cent. He thought that the debentures ought to be paid off. The revenue had been charged with £50,000 on account of the Western Australian cable, and the amount carried forward was £26,000. He really thought, in view of the Company's prosperity, that an extra 1 per cent. dividend might be paid.

The Chairman said he had admitted that in writing £50,000 off the cost of the Western Australian cable they had done a great thing. The shareholders should, however, remember that the Company was in a position that it could be "shot at," and the policy of the Directors was to protect the Company in every way, so that, while maintaining a respectable dividend, the value of the property was being materially increased. The effect of that policy was seen in the market price of their shares. After the Berlin Telegraph Conference, at which their tariffs were reduced by £40,000 per year, it was decided to pay a bonus only once a year, while declaring a steady dividend of 5 per cent. That course had since been adopted. They would be happy to deal with the six per cent. debentures at once, but the holders would not part with them. However, the debentures would mature two years hence, and they would certainly not be renewed at 6 per cent.

The motion was then adopted.

MONTE VIDEO TELEPHONE COMPANY, LIMITED.

The first annual general meeting of this Company was held on Friday, the 18th inst., at the offices, Abchurch-lane. Mr. Arthur Holland presided, and, in moving the adoption of the report, observed that the Directors regarded the profit of £10,302 on the past year's working as extremely satisfactory. They had had to contend against the usual dislocations which took place when an enterprise was transferred from one set of managers to another; and they had also suffered severely from a cyclone last February, the damage done entailing considerable expense on the revenue account. Comparing their expenses with those of other similar enterprises, particularly in Buenos Ayres, they stood favourably, their outlay being 45 per cent. against 50 per cent. They recommended the payment of the full six per cent. dividend on the preference shares, the transfer of £1,000 to renewal fund, which they considered only a prudent measure, and the payment of a dividend of 2½ per cent. on the ordinary shares, leaving £325 to be carried forward. The amalgamation with the Company of the Gower Bell Telephone Company of Monte Video they had considered expedient, for it not only consolidated their position, but put a stop to any other companies having a footing in Monte Video. In order still further to perfect their own telephonic system, they had decided, under the direction of their able managers, to institute what was called the multiple switchboard, which would do away with the annoyance experienced by subscribers in having to wait to be switched on to clients. The cost of the improvement would be between £5,000 and £6,000. Judging from the experience of other companies, they anticipated a large increase in the number of their subscribers in consequence of the adoption of the multiple switchboard, and the importance of this increased business would at once be manifest to the ordinary shareholders. They also looked to derive additional business from the "boom" of prosperity which seemed at last to have burst upon Monte Video and Uruguay. The trade of Uruguay increased in 1888 over 1887 by upwards of 30 per cent.

Mr. Thomas D. Peters seconded the motion, which was unanimously adopted, and the dividends recommended were afterwards approved.

CITY NOTES.

West India and Panama Telegraph Company.—The traffic receipts for the half-month ended October 15 were £2,053, against £2,557.

Eastern Extension, Etc., Company.—The Directors of this Company notify that the coupon on this Company's five per cent. debentures (1880 issue), due on November 1, will be paid on and after that date on presentation of the same at the Consolidated Bank, 52, Threadneedle-street, E.C. Coupons must be left three clear days for examination.

West India and Panama Telegraph Company, Limited.—The Directors propose the payment of 6s. per share, balance of arrears, and a dividend of 6s. per share on the first preference shares, and 10s. per share on account of arrears on the second preference shares, and after transferring £2,000 to reserve, a balance of £1,609 will remain to be carried forward.

PROVISIONAL PATENTS, 1889.

OCTOBER 14.

16130. **An improvement in conductors or poles for use in electrical furnaces.** Alfred Edward Robinson, Electric Construction Corporation, Limited, Wolverhampton.
16144. **An improved electric tell-tale clock.** Henry Haymen, Somerset Chambers, 151, Strand, London. (Albert Gunder-sen, New Zealand.) (Complete specification.)
16148. **A new or improved invisible portable contact for house telegraphs and electric conductors.** Hermann Studte, 34, Southampton-buildings, Chancery-lane, London. (Complete specification.)
16165. **Improvements in electrical fusible cut-outs.** Edward William Lancaster, Temple Chambers, Temple Avenue, London. (Claude Grivolos, France.)

OCTOBER 15.

16210. **Improvements in electric dry batteries.** Alfred Wolf-schmidt and Carl Brehm, 6, Lord-street, Liverpool.
16231. **Improvements in dynamo-electric generators.** Gustav Pfaukuche, 18, Buckingham-street, Strand, London. (Complete specification.)
16241. **Improvements in secondary or electric storage batteries.** Hiram Henry Carpenter, 77, Chancery-lane, London. (Complete specification.)

OCTOBER 16.

16275. **Improvements in electrical switches.** George Henry Bassano, 33, Garden-street, Derby.
16331. **Improvements in the manufacture of illuminants or light-emitting conductors of electric lamps.** James Clegg, 24, Southampton-buildings, Chancery-lane, London.

OCTOBER 17.

16366. **Improvements in electric cables.** Daniel Sinclair and Hubert Feilden Jackson, 62, St. Vincent-street, Glasgow.
16374. **An improved portable electric lamp.** Auguste Serrailier and George Pulling Armstrong, 29, Meek-street, West Bromp-ton, Middlesex. (Complete specification.)
16375. **Improvements in secondary batteries.** Charles Barrall de Montaud, 28, Southampton-buildings, London.

OCTOBER 18.

16466. **Improvements in electric meters.** Charles Nichols, 11, Shalcombe-street, King's-road, Chelsea.
16500. **Improvements in and relating to electric regulators or balances.** Frédéric Victor Maquaire, 45, Southampton-buildings, London.

OCTOBER 19.

16537. **Improvements relating to insulators for electric wires and to supports therefor.** Dan Rylands, 45, Southampton-buildings, London.
16564. **Improvements in apparatus for winding clocks by electricity.** Henry Harris Lake, 45, Southampton-buildings, London. (Frank Edward Morgan, United States.) (Complete specification.)

SPECIFICATIONS PUBLISHED.

1888.

13687. **Electrical furnaces.** Crompton. 8d.
13805. **Applying electricity to vehicles.** Wynne. 11d.
15395. **Measuring electric currents, &c.** Cardew. 8d.
15530. **Electric indicators.** Paul. 8d.
16471. **Dynamo-electric machines.** Raworth. 11d.
16766. **Electric lamps.** Shepard. 8d.
17238. **Electric dry piles.** Dymond (Moorthamers). 6d.
17537. **Secondary batteries.** Bailey and Warner. 8d.

1889.

6104. **Incandescent electric lamps.** Lake (Tibbits). 3d.
9508. **Arc lamps.** Sperry. 8d.
11019. **Electric railways.** Weems. 1s. 1d.
11471. **Electric accumulators.** Reynier. 8d.
12145. **Generating electricity.** Justice (Acheson). 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name	Paid.	Price Wednesday
12 Feb.	1/2	Anglo-American Brush E.L.	—	4½
12 Feb.	2/0	— fully paid	—	5½
14 Nov.	0/4½	Con Telephone & Main ...	1	4½
27 July	10/0	India Rubber, G. P. & Tel.	10	19½
.....	...	House-to-House	4½	5
.....	...	Metroptn Electric Supply	—	3½
.....	...	London Electric Supply ...	5	4½
.....	...	Swan United	3½	5½
12 July	12/0	Telegraph Construction ...	12	43½
2 July	6/0	— 6%, 1889	100	105
... ..	...	National Telephone	5	6½

NOTES.

Paris Exhibition.—The Paris Exhibition will be closed absolutely on November 6.

St. Petersburg.—The Alexandrewski Theatre in St. Petersburg has been lighted with electric light.

Bordeaux.—The Grand Theatre of Bordeaux has just been fitted throughout with 750 lamps of 16 c.p.

Increase.—The Thomson-Houston Company increased its stock on October 5 by a million and a half dollars.

Automatic Boxes.—An official liquidator has been appointed for the Electric Automatic Delivery Box Company.

Walthamstow.—The Walthamstow Local Board are going to consider the advisability of having a central station of their own.

Admiralty.—An alteration is announced to be made in the arrangement of the electric search lights of the "M" class of Her Majesty's cruisers.

Atlantic Cable.—Another cable is announced to be added to those already crossing the Atlantic, and is to go direct from Ostend to North America.

Subways.—A large subway for pipes and electric wires will be built under the new street from the Strand to Holborn, proposed by the London County Council.

Croydon.—Three companies are applying for powers in Croydon. The Council have decided to open negotiations, and see which company will give the best terms.

Russian Ships.—A sum of 166,000 roubles is to be spent this autumn by the Russian Government in fitting up all the vessels of the Black Sea and the Baltic fleets with electric light.

British Association.—The Leeds Corporation have received an application for the use of the Victoria Hall and rooms in the Town Hall during the visit of the association to the town next year.

Russian Telegraphs.—It is announced from St. Petersburg that all foreigners on the Government telegraphs must become Russians before the 1st of January next or leave their places.

The Telegraph in Central Asia.—Telegraph stations are being established at Jolotan, Sari-Yazi, and Tachta-Bazaar, along the line of telegraph between Merv and Penjdeh, in Central Asia.

Cancelling Money.—General Rosecrans, Registrar of the American Treasury, has decided to introduce electric motors into his office to run the punching machines for cancelling the redeemed Treasury notes.

Egypt.—The casino of Helouan, near Cairo, is to be lighted with electric light by the Continental Edison Company, who will also supply a luminous electric fountain to enhance the beauties of this pleasure resort.

Sale by Auction.—We would remind our readers of the sale of electrical and mechanical plant which is to take place to-day at 1 o'clock, at 31, Golden-square. Full particulars of the sale were given in our last issue.

Prize.—The Technical College of Darmstadt offers a prize of 150 marks to the author of the most exact method of determining the losses in transformers due to Foucault currents and to periodic changes of electric state.

Arc Prices.—For the lighting of Buffalo, U.S., the tenders of the Brush, the Thomson-Houston, and the United States Companies, for lighting streets and buildings for only one year, were all 42½ cents per light per night.

Personal.—Sir George Elliot, M.P., has been appointed chairman of the Telegraph Construction Maintenance Company, in place of the late Sir Daniel Gooch. Sir George Elliot has been a director of this company since its formation.

Vienna.—The streets of Vienna have been very badly "up" owing to the laying of electric mains for the new central stations. The station at Neubad is nearly finished, Messrs. Siemens and Halske doing their best to be the first to supply current to the public.

Birmingham Electrical Exhibition.—In our last issue, when mentioning the names of the firms who had been awarded first-class silver medals for their exhibits at the above, we gave the name of Müller, London; this should have been Chas. A. Müller, Bradford.

Paris Central Station.—The work of fitting up the municipal central electric lighting at the Halles Centrales is now almost finished, and in a few days the service will be maintained regularly. This station is to light the Paris markets and the streets in the vicinity.

Athens.—The Continental Edison Company received an order to light the streets, squares, and buildings of Athens on the occasion of the marriage of the Prince of Greece. Four Edison dynamos of 500 amperes and two Weyher and Richmond engines of 170 h.p. were sent to Athens.

Uranium.—The discovery of an uranium lode in a tin mine in Cornwall has been the subject of a company, whose shares were offered for subscription last week. It is expected that the uranium may be largely used in electrical fittings and apparatus instead of platinum.

Telegraphs in China.—The necessary measures have been taken to connect Chinese telegraphs to the Russian system. An offer has been made to the Chinese Government for the construction of a line from Peking to Chin Kiang, the cost of which is given at 70 million dollars.

Edinburgh.—The Lord Provost's Committee at Edinburgh have decided to adhere to their course to decline to sanction proposals by outside companies for lighting and to oppose any applications made for powers, and further at present to take no action themselves in the meantime.

Sevenoaks.—Last week at the Sevenoaks Local Board, mention was made of a letter received from the Electric Trust, Limited, proposing to apply for a provisional order. The clerk said the chairman of the trust had called on him and had told him if there should be opposition they would not persist in applying for the order. The matter then dropped.

Public Buildings.—The American Treasury department has a number of contracts given out for lighting public buildings with the electric light. It is thought that the State Department building at Washington may be lighted, for which some 5,000 lamps would be required. If this is done, the White House may also be lighted from the same plant.

Electric Stamp.—The wonderful invention which it has been announced that M. Somzie has bought from Messrs. Lee, Ross, and Co., for several thousand francs, turns out to be an automatic stamp to control the pay

ments and receipts in factories, banks, and hotels. A company has been formed, with a capital of 3,000,000f. It is stated that orders have already been received for about 2,000 stamps in Brussels.

Copenhagen.—The Municipality of Copenhagen have decided to construct and carry on one or two central electric light stations for the use of the town, which possess several sites suitable to this purpose. The cost of the first station is estimated at about £90,000. This is to supply 10,000 lamps capable of being raised to 14,000 on occasion, and the district of lighting is to extend to not further than about 600 yards from the central station.

The Brass and Copper Trades Pension Fund.—The trustees and supporters of the above fund held their usual meeting on Thursday, Oct. 24, at the Holborn Restaurant, Major-General Lambert, Prime Warden of the Goldsmiths' Company, presiding. An excellent dinner was served, and the usual toasts discussed between the intervals of songs and glees. Donations to the amount of £156 were collected during the evening.

Electric Ventilation.—A system of ventilation for subways is to be tested in St. Louis, which consists in reality of a series of "electric stores" placed at intervals along the mains. These are formed of zinc boxes containing a small resistance coil, which is constantly heated nearly to a white heat by the current from the mains. The heat generates a current of air which abstracts any explosive gases that may have found their way into the conduits.

Constantinople.—The Palace of Yldiz-Kiosk at Constantinople is to be lighted with the electric light. The Turkish Minister has given the contract to the firm of Sautter, Lemonnier, and Co., of Paris, who are to prepare it for the approaching visit of the Emperor of Germany. The installation will consist of 400 incandescent lamps. The French papers are jubilant over this triumph of French industry in auguring electric lighting for the reception of the German Emperor.

Personal Progress.—Mr. James Raeburn has been appointed an electrician to the Thomson-Houston Company at Hamburg. Mr. Herbert E. Sturr has also been appointed to the central electric lighting station at Exeter, and Mr. Arnot has gone to Melbourne to fit up an electric tramway and represent a well-known electrical engineering firm, at £500 per annum. The above mentioned were all students of the Glasgow and West of Scotland Technical College electrical engineering classes.

Still in its Infancy.—The members of the Strand Guardian Board must be peculiar in the development of their ideas. With the electric light mains right under their noses, they still ramble on with the old absurd phrases. At the last meeting the General Purposes Committee recommended that the tender of Messrs. Verity for electric lighting in the Board-room, amounting to £92, be accepted. A long discussion ensued on this question, and it was ultimately postponed on the ground that as electric lighting was in its infancy the guardians had better not enter into a contract at present.

Birmingham Tramcars.—A trial trip has been made on the Bristol-road route, Birmingham, with the first of the electric cars which are to run upon this line. The idea of having a separate electric locomotive has been abandoned, and the car is now constructed as a self-contained car. The car is lighted with incandescent lamps

and fitted with an electric gong. The storage cells are placed along the sides of the car, and the motor is placed on the front bogie of the framework. It is understood that the supply of energy is sufficient to run the cars 70 miles without changing cells.

Institution Dinner.—Sir William Thomson, president of the council of the Institution of Electrical Engineers, has issued invitations to the members to a dinner on Monday next, November 4, at 7 for 7.30 p.m., at the Criterion Restaurant, Piccadilly. The following are some of the distinguished guests who have accepted the invitation: The Marquis of Salisbury, the Astronomer Royal, the Hydrographer to the Admiralty, Mr. Courtenay Boyle and Major Marindin, R.E., Board of Trade, Dr. Anderson, the Presidents of the Royal Society, the Physical Society, the Institution of Civil Engineers, the Iron and Steel Institute.

Rather Tall.—A gentleman employed at a colliery a few miles from Glasgow had a dog called Jimmy, which he parted with to a friend at a colliery some miles distant. The two offices are connected by telephone, and the other morning the gentleman rang up his friend and asked how Jimmy was doing. "Oh, he's fine," was the answer. "He's at my feet just now. I'll hold him up and see if he knows your voice." This was done, and the former owner shouted over the wire, "Hillo, Jimmy!" Jimmy made no sign of recognition, but on being set down again he at once made for the door, and when his old master went home to dinner the dog was there to welcome him!

Electricity and the Muscles.—In the *Proceedings* of the Royal Society of Edinburgh (session 1888-9, p. 234) there is an interesting but rather abstruse article upon the effect of electric stimulation on nerve and muscle, by George N. Stewart, D.Sc., Owens College, Manchester. The experiments were carried on partly at Owens College, and partly at Edinburgh in the laboratory of Prof. Rutherford. Dr. Stewart says he does not propose to discuss the real significance of his results at present as he hopes to have an opportunity of so doing in connection with a more extended research, embracing the effect of stimulation on the whole of the polarisation phenomena of nerve and muscle. He considers it by no means impossible that a real positive electro-tonic variation may be mixed up with a true action current in the positive direction.

Electricity from Solar Radiation.—At the conclusion of a series of experiments made from the month of May, 1885, to the month of July last, M. A. Nodon has come to the conclusion that solar radiations are the cause of certain electric phenomena. The study of these he sums up in the following laws: (1) The solar radiation in coming against an insulated conductor of metal or carbon communicates an electro-positive charge. (2) The importance of this charge increases with the intensity of the solar radiations, and diminishes with the hygrometric state of the air. The phenomena reaches at Paris its maximum value in summer, about one o'clock in the afternoon, when the air is pure and dry. (3) The passage of the clouds in front of the sun causes the phenomena to cease.

A Liverpool Physical Society.—The rapid advances being made in electrical and kindred sciences call for centres in the large towns round which intelligent students can gather, and to this end it is proposed to form a Physical Society in Liverpool for the study of the physical sciences, pure and simple, which will hold its meetings at University Colleges. Prof. Oliver Lodge has consented to be nom-

inated as first president. It is intended to make the society as popular and comprehensive as possible, without trenching on the ground occupied by existing societies. The annual subscription will be about five shillings. The preliminary meeting of this new society will be held in the Physics Theatre of University College at 8 o'clock on Wednesday evening, November 6th, when Prof. Oliver Lodge will take the chair. Local students and all others interested are invited to be present. The secretary (*pro tem.*) is Mr. Thomas Tarleton, 1, Hyde-road, Waterloo, Liverpool.

Electric Lighting at Stafford.—At a special meeting of the Town Council, held on the 29th ult., a special committee reported that it was undesirable to allow a company to supply electric lighting within the borough, and that application should be made to the Board of Trade to authorise the Corporation to make the supply. It was also moved that consent be not given to the granting of a provisional order to the Midland House-to-House Electricity Company, Limited (which company our readers will remember is one of the dozen or so initiated by Mr. Robt. Hammond), and that application be made to the Board of Trade for the granting of a provisional order authorising the Corporation to erect and maintain electric works and lines within the borough. The arguments on behalf of the motion were chiefly that the Corporation had invested about £85,000 in the gas works, and that if they allowed a private company to take all the profits of electric lighting they might whistle for their money. The motion was finally carried, and the town clerk was instructed to take the necessary steps to carry out the resolution, Alderman Peach and Goodall, and Messrs. Wright, Bagnall, Matthews, and Wonnal being elected the Electric Lighting Committee.

Electro-Harmonic Society.—A smoking concert in connection with the above society will take place this evening at the St. James's Hall Restaurant. The following programme will be carried out—Part 1: duet, "Love and War" (Cooke), Mr. T. W. Page and Mr. Musgrove Tufnail; solo violin, "Elegie" (Ernst), Mr. T. E. Gatehouse; air (*Semele*), "Where ere you walk" (Handel), Mr. T. W. Page; song, "Two Grenadiers" (Schumann), Mr. Musgrove Tufnail; solo pianoforte, "Rigoletto" (F. Liszt), Mr. Alfred Izard; humorous sketch, Mr. Frederic Upton. Part 2: old trio, "The Wreath" (Mazzinghi), Mr. T. W. Page, Mr. Arthur Thompson, and Mr. Musgrove Tufnail; solo violin, "Hungarian Rhapsody" (Hauser), Mr. T. E. Gatehouse; song "Tom Bowling" (Dibdin), Mr. T. W. Page; descriptive scena, "Travellers all" (Balfe), Mr. Musgrove Tufnail; humorous sketch, Mr. Frederic Upton; song, "Venetian Song" (Tosti), Mr. Arthur Thompson; finale, "Good Night," watchman's song (Pearsall).

Birmingham Electric Lighting Order.—Messrs. Chamberlain and Hookham recently obtained, it will be remembered, with the consent of the municipal authorities, a provisional order empowering them to supply electricity in a central area of Birmingham. One of the conditions made by the Birmingham Corporation was that a company should be formed to carry out the scheme, with a minimum capital of £50,000. It is now stated that the provisional order is to be placed in the hands of a strong combination to fulfil this condition. Messrs. Holmes and Vaudrey, electrical engineers, of Liverpool, have, we are informed, arranged with Messrs. Chamberlain and Hookham to purchase their interest in the order for a

comparatively small sum, and in the event of the company to be formed appointing them engineers, which will no doubt happen, they will transfer the order to the company at the same price which they have paid to Messrs. Chamberlain and Hookham. An influential directorate is in course of formation, including two well-known Birmingham men, and the capital of the company will be in excess of the minimum fixed by the order. The prospectus will be placed before the public eight or ten days hence, but we are informed that large numbers of shares have practically been already taken up. An entirely underground system will be employed at Birmingham, similar to that adopted at Liverpool, in which Messrs. Holmes and Vaudrey are interested.

Groth's Electric Tanning Process.—Experiments have been going on for some time with a new method of tanning by electricity at the tannery of Messrs. Tebbitt Bros., 48, Tanner-street, Bermondsey. This is the invention of Mr. L. A. Groth, of 3, Tokenhouse-buildings, London, and the system was shown in operation last week. The time required in the production of leather on the ordinary old-fashioned plan is 12 months, though this is reduced by some tanners to six or even in inferior kinds to four months. By the electric method Mr. Tebbitt, who should be able to judge, maintains that the best sole leather or butts can be turned out in one month. The process consists in hanging the skins on a revolving framework of wood driven by a steam-engine, which constantly keeps the hides sweeping round inside the tanning solution eight hours a day for a month, or, if desired, sixteen hours a day for a fortnight. The solution is kept warm, and the vat is supplied with copper plates connected to a low-tension dynamo, so that the current continually passes through the liquid as the skins revolve. It is stated that there is a saving of 80 per cent. on labour, and sole leather can be turned out at 2½d. per pound as against 4½d. on the old system. The explanation of the saving in time is that the electricity promotes the combination of the tanning of the bark with the gelatine of the hide during the tanning. The single set of apparatus shown is stated to take the place of 30 or 40 ordinary pits, and it has now been in successful operation at the above-mentioned tannery for about 12 months. A company will be formed to work the system.

Cheltenham Decides to Apply for Powers.—A special meeting of the Cheltenham Town Council was held last week, to consider whether application should be made to the Board of Trade for a provisional order authorising the Corporation to supply electricity for public and private purposes within the borough, and, if deemed expedient so to do, to enter into contracts with any company or person for the execution and maintenance of works for the supply of electricity; and further to consider whether the Corporation should refuse their consent to grants of provisional orders to all the parties who have given notice of their intention to apply for provisional orders. Mr. G. Norman, chairman of the Electric Lighting Committee, proposed that application be made to the Board of Trade for a provisional order by the Corporation, and that consent be refused to grants of orders to private companies. He remarked that the only question the Council had now to consider was whether the light should be introduced by themselves or by private speculators, they having on several previous occasions affirmed the desirability of introducing the light. Mr. King seconded the motion. Mr. Neale proposed an amendment in favour of allowing the

light to be introduced by a private company, and Mr. Ferguson seconded the amendment. Messrs. Hands, Heath, and Darby, and Alderman Parsonage, took part in the discussion, the latter pointing out that the question was not whether £12,000 or any other sum should be expended in the introduction of the light, but whether the Corporation should get possession of the ground and keep other companies out. Mr. Neale subsequently withdrew his amendment, and after a few remarks from the Mayor, and Mr. Norman's reply to the criticisms, the original resolution was unanimously carried.

Extension at Bradford.—At a special meeting of the Bradford Town Council held last Saturday, Alderman Frederick Priestman moved the adoption of the proceedings of the Gas and Electricity Committee, which included a resolution to borrow an additional sum of £25,000 for extensions of the electricity works to meet the growing demands for electric lighting. He said the committee had no new scheme before them, and did not intend to spend the whole amount at present; but it was necessary for them to have £10,000 more with which to carry on the present works. The existing borrowing powers for electricity had already been slightly exceeded in carrying out the present works for supplying electricity, and their object in asking for the larger sum was merely a precaution to save the expense which would be involved in making three or four applications as the necessity to meet additional expenditure arose. He was prepared to give a pledge that no part of the money beyond the sum of £10,000 should be expended without obtaining the sanction of the Council. Mr. D. Barker seconded the motion. Mr. Shackleton asked if the chairman of the committee would give a pledge that the money should not be spent till the existing works proved remunerative? Alderman Frederick Priestman replied that he could not give a pledge of that kind, because demands for electricity were being made by the ratepayers in various parts of the town, and if the Corporation did not comply with the request, they might be compelled to do so or allow a private company to provide a supply. The electric works would be more likely to prove a financial success if the Corporation were enabled to extend the mains, and thus supply electricity to a larger number of customers. Mr. Shackleton expressed his dissatisfaction with extended expenditure before the present electric works became remunerative. The motion confirming the action of the committee was then agreed to.

Burton Electric Heaters.—The Burton Electric Company, on October 17, shipped to St. Louis the Burton electric heaters, to be used on the cars of the St. Louis and East St. Louis electric railway, which crosses the Mississippi river on the famous Eads bridge. The equipment of these cars with electric heaters, besides being a novelty, possesses other features which will be interesting to electricians and electric railway officials generally. Each car will be provided with six heaters, four inside the car, two on a side, placed under the seats, and one on each platform, flush with the floor, for the motor man at one end and the conductor at the other to stand on. The heaters, by switches, can be connected in series of four or six at the will of the operator. For instance, before starting out in the morning, the four heaters inside the car are switched into series for the purpose of warming it up rapidly. With an electrical resistance of 21 ohms each, these, on a 500-volt circuit, will use about five amperes of current; but in 20 minutes they will attain a temperature of considerably over 212deg. Fahr. After this has been accomplished another switch throws the plat-

form heaters in series with those on the inside, when the use of current is reduced to three amperes, which, from actual tests, has been found sufficient to maintain the heat in the inside ones, and at the same time raise the temperature of those on the platforms sufficiently to comfortably warm the feet of the motor man and conductor during the coldest weather of that latitude. The expense represented in this work is in the use of coal at the generating station, which, by a close calculation, would not amount to more than 15 or 20 cents. per day per car, or actually less than the cost of coal burned in a stove to warm a car. Besides, the constant temperature of the heaters, their ease of management, their cleanliness and absolute safety, place them at once to the front as the heater *par excellence* for electric cars. The order for these heaters was the outcome of their exhibition at the St. Louis Exposition, where they attracted great attention.

Electric Launch.—The following details are given of the American electric launch, "Electron," which has lately had some successful runs in New York waters. Being built for pleasure purposes to carry a fair number of passengers and a large quantity of storage batteries for lengthened trips, it has more than the usual amount of beam. Great speed was not aimed at, but as high a speed as 12 miles an hour has been easily obtained. The hull of the "Electron" is constructed of sheet-iron plates $\frac{1}{8}$ in. in thickness, and is 36ft. long over all. It is decked over forward and aft, and has a raised roof amidship which provides a roomy cabin, the fore part of which serves for a pilot-house, where all switches and indicators are in easy reach of the man at the wheel. The screw of the launch is 18in. in diameter and of a pitch to allow the motor to revolve at about 1,000 revolutions per minute for its maximum speed. The motor is coupled direct to the screw, the armature-shaft and screwshaft being rigidly united and practically forming a single shaft. Between the motor bearings and stuffing-box there is a spring bearing and a double-thrust bearing, all easily accessible for oiling. The motor is placed beneath the cabin floor, somewhat back of the centre of the boat, and is entirely exposed by the removal of a glazed trap-door. The motor is a series-wound, and weighs about 500lb., takes a current of 70 amperes at 200 volts, or nearly 20 e.h.p. The normal working rate of the batteries is 50 amperes at 200 volts. The storage battery consists of 200 cells, weighing four tons, each cell containing 23 plates, the cell being of vulcanite $6\frac{1}{4}$ in. long by $7\frac{1}{2}$ in. wide by $9\frac{7}{8}$ in. high, closed by a hermetically-sealed vulcanite cover, save for a small perforation in a vulcanite knob in the cover which allows any excess of gas to escape. These 200 cells are arranged in the boat, some in the bottom, others under the forward deck, and the remainder under and back of the seats, which extend along both sides of the cabin. All of the cells are accessible for inspection. The electric launch seems likely to become a favourite hobby of the millionaire pleasure-seekers of the States.

The Edinburgh Electrical Exhibition.—A special meeting of the electrical trades section of the London Chamber of Commerce was held on Monday with reference to the proposed Edinburgh Exhibition. Major Flood-Page (the chairman) said it had been determined to hold next year in Edinburgh what was called an International Exhibition of Electrical Engineering, General Inventions, and Industries. Some of the rules which had been drawn up were very stringent, and he thought the time had come when everybody connected with the electrical industry should speak out. They would agree that exhibitions,

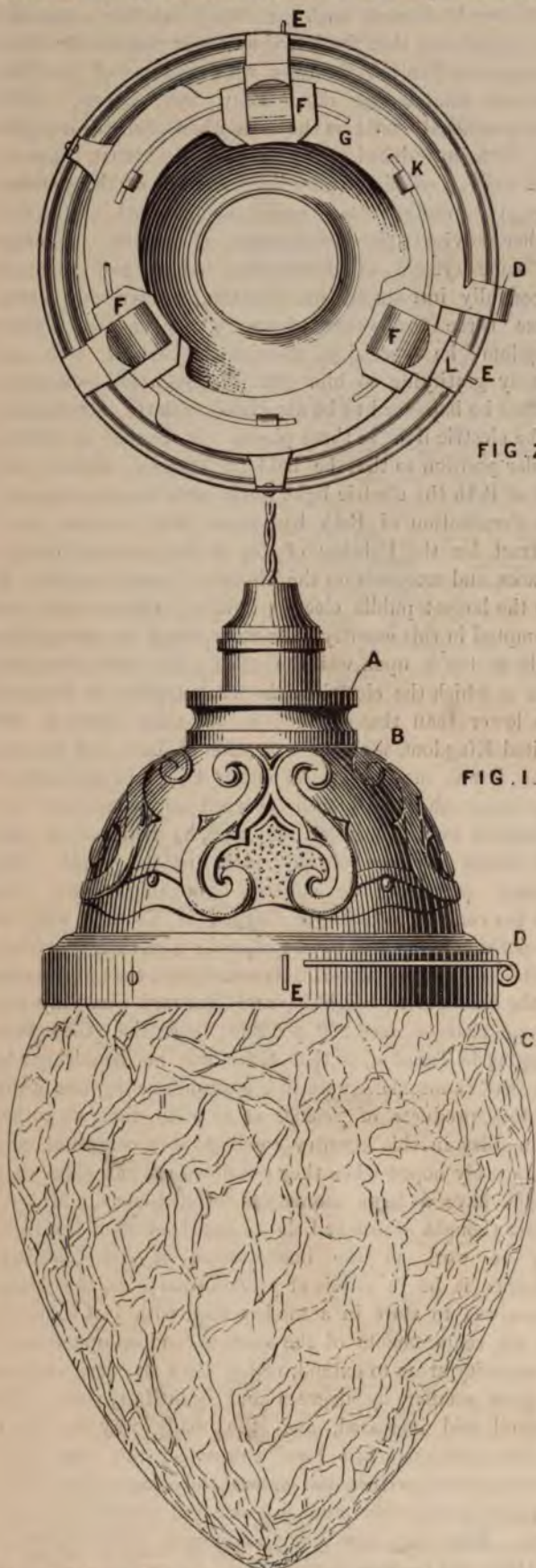
especially when 400 miles away, were very expensive. They got very little out of them, and it was neither fair nor reasonable that gentlemen in Edinburgh who wanted to make money for the people there should call upon others to bear the expense which was necessary for such an exhibition. If the electrical profession responded, the amount that they would have to expend would be measured by tens of thousands of pounds. It was within his own knowledge that one firm had spent about £6,000 in connection with one exhibition, and yet they were unable to trace a single order from it. He would, therefore, suggest—not that they should not exhibit—but that they should exhibit on their own terms and not on the terms of the exhibition authorities. He would like to point out that an electrical exhibition could not be successful without the help of the electrical trades section of the Chamber of Commerce; in fact, it could not be undertaken if they chose to stand out, for they embraced almost the entire electrical world. However, they were now called upon to pay for space, for the delivery, arranging, fixing, and the cost of installation; and they had to insure and pay for any damage that might be incurred. Further than that, the authorities took to themselves power to alter the rules if they thought fit, and the exhibitors must abide by them. The time had come when they ought to be able to arrange at least for the rent being free. There was, according to the plan, to be a special place called the machinery and electrical hall. If the trade exhibited there they ought to demand free rent, free power, and free current, and they ought not to have to send their own men such long distances simply to look after the cases. The exhibition authorities ought to take the responsibility of that. A resolution was agreed to appointing a committee to consider the conditions on which it might be advisable to take part in the exhibition.

Increase of Plant at Taunton.—A special meeting of the Taunton Electric Light Company was held last week for the purpose of passing a resolution to issue £10,000 of new stock, in 2,000 £5 shares, to be offered to the shareholders in the first instance. Mr. Massingham said it gave him great pleasure to see the finances necessitated such a resolution. Four years ago they had only one dynamo, now they had six, and the works would hold no more; they were obliged to refuse further customers. The directors had purchased another plot of land, and were building an entirely new depot, which, he thought, would be a model station, which they could show to the numerous deputations that continued to wait upon them from all parts of the United Kingdom. He was very pleased to say that as a result of the visits they had received, and especially of the visits of electrical engineers, the electric light industry had received a great impetus throughout the country. Amongst the gentlemen who had been to Taunton to see the light he might mention the late President of the British Association, Sir Frederick Bramwell, who had been asked to advise the Corporation of Bedford as to the advisability of introducing the electric light in the town. Previous to his visit a deputation from the Corporation came to Taunton, and they were so pleased that they asked Sir Frederick Bramwell to see the Taunton depot too. Major Waller, secretary of the Electric Supply Corporation of London, who were building huge works at Deptford, had also been down to inspect the works. Practically all that was being done in London was an imitation of what they had successfully accomplished in

Taunton on a small scale, which the Londoners were going to do on a more gigantic scale. Mr. Massingham also referred to the report of Mr. Preece, who was advising Bristol, who, although largely interested in gas, had no fear that electricity would do away with gas. He practically supported their experience that the introduction of the electric light was no more likely to do away with the use of gas than the steam-engine had done away with horses, which many predicted would be the case when the steam-engine was first introduced. Mr. Preece held that, next to pure water, a supply of pure light was one of the greatest acts of sanitation that could be adopted. He also further advised the Corporation of Bristol to adopt the same system of distribution which had been so successfully introduced in Taunton, Exeter, and Bath. These three towns out of the whole of the United Kingdom he specially mentioned, and it was extremely gratifying to him (Mr. Massingham) personally, because he happened to be associated with the introduction of the electric light in those places. In Exeter he held a similar position to that he held in Taunton, while in the case of Bath the electric light works were his own property. The Corporation of Bath had given him a seven years' contract for the lighting of 50 of the principal streets, squares, and crescents on the Thomson-Houston system. It was the largest public electric lighting contract ever yet attempted in this country. Another thing he thought he ought to touch upon was the price. He found that the price at which the electric light was supplied in Taunton was lower than that charged in any other town in the United Kingdom, with the exception of Bath and Exeter, where it was the same. As far as he could ascertain, it was lower than had been charged anywhere on the Continent or in America. In fact, he believed it was the lowest in price of any place in the world. The average price of the electric light in London was 100 per cent. more than was charged in Taunton, even in competition with those large companies with their enormous capital and greater power. He found, too, that in the case of the Eastbourne, Brighton, and Hastings Company the average charges were 200 per cent. more than they were charging in Taunton, so that there was no disguising the fact that Tauntonians were in a position to enjoy one of the greatest products of science at a price that no other community in this country could possibly command, and he sincerely hoped when they put down the new plant they should have a large acquisition of customers. Mr. W. Potter thought events had shown that they went the right way to work in the inauguration of the company. Whether it be in public or private enterprise, the wisest course was to start in a modest way, with just sufficient for the requirements of the moment, and as opportunity or necessity arose to extend, rather than as time went on to grow smaller by degrees and beautifully less. The demand had increased, and the ready way in which £5,000 additional had been subscribed was very satisfactory to the directors, and showed the company had taken its place in the public mind as a safe and profitable investment. They were now going to increase their capital to £20,000, and he thought they could do so with confidence from their previous success. They had secured a splendid site, central in position, and free from danger from flooding, one also which would allow of considerable extension, should occasion arise, as he hoped it would from time to time, by growth of their business. The resolution to increase the capital was carried unanimously.

THE ATKINS' PATENT LAMP-SHADE CARRIER.

We have received a very ingenious device designed by Mr. Atkins for enabling a glass shade, or cone, to be easily attached to or detached from an ordinary incandescent



lampholder. We illustrate it above: Fig. 1 represents the lamp complete, A being an ordinary holder, B the brass cap containing the patent arrangement, and C the glass cone. In order to detach the cone one finger is placed on the projection E, and the piece, D, drawn towards it; the action will be easily understood by reference to Fig. 2. In moving D the ring, G, is drawn round, being guided in a circle

by the pieces K; this causes the three clips, F, to be carried further out in a radial direction, they being prevented from any other movement by being made to embrace the pieces L, which form part of a light ring underneath G, of which the pieces K are also parts. The action is quite similar to that used in the Acme skate, and is so simple that we are sure it will come largely into use. This shade is being introduced by Messrs. Drake and Gorham, of 2, Princes-mansions, Victoria-street, S.W.

ELECTRIFICATION OF AIR BY FLAME.*

BY SIR WILLIAM THOMSON.

In continuation of experiments on the electricity of air within doors, which I made 27 years ago, and which are described in §§ 296-300 of my "Electrostatics and Magnetism," a series of observations was commenced under my instructions at the end of April last, within the natural philosophy classroom and laboratory, the Bute Hall, the university tower, and other places inside and outside the buildings of Glasgow University, by Mr. Magnus Maclean, official assistant to the professor of natural philosophy, and Mr. Goto, of Tokio, Japan, for the purpose of endeavouring to find a relation between the electrification of air within a building and the atmospheric potential in its neighbourhood outside; and of finding causes which produced or changed the electrification of any given mass of air.

A large number of series of observations have been made by Mr. Maclean and Mr. Goto on the potentials of water-dropping collectors within the building, and at different points outside the building. Hitherto no definite relation has been discovered between the external potential and the potential at different points within large enclosures, such as the Bute Hall and smaller rooms of the university buildings. The weather has been for the most part very settled, and the external potential almost always positive in all positions from a few feet above the ground to the top of the university tower; while the potential within doors here, in the new university buildings, on the top of Gilmour-hill, just as in the old college, down in the densest part of Glasgow, was always negative except sometimes in the natural philosophy lecture-room and apparatus-room, where there were considerable disturbances, undoubtedly due to the electric light wiring. In one ordinarily unused room (the physical apparatus museum), 31½ ft. long by 24 ft. broad and about 20 ft. high, practically quite free from any sensible disturbance by electric light wires, or by electrical operations being performed in the laboratory, a remarkable result has been observed within the past fortnight. The electric potential of a water-dropper, having its nozzle at the centre of the room and about 7 ft. above the floor, was always found about two volts negative at the commencement of the observations, and always increased to about nine volts in the course of the first 20 minutes of a series of observations lasting generally 40 minutes. During the last 20 minutes of the series the potential remained somewhat nearly constant at nine volts. Within the room, two quadrant electrometers, each with an ordinary paraffin lamp and scale, were used; one of them for the outside water-dropper, and the other for the water-dropper within the room.

Towards ascertaining the cause of this change, an observation was made on the 4th July, between 10 and 11 a.m. The lamps were both extinguished, and one of them was lighted by a lucifer match every five minutes for the purpose of reading the electrometer deflection. It was found that in these circumstances there was not the increase of negative potential which had been found in every previous series of observations in the same place, and with all other circumstances the same, except the burning of the lamp. This single observation seemed to prove conclusively that the burning of the lamp produced a negative change of the air of the room. Subsequent experiments made by Mr. Goto, with the electrometer and its lamp and scale outside, and with paraffin lamps burning or not burning within the room, have confirmed this result, and are being continued to discover whether corresponding effects are produced by other kinds of flame, or by the presence of eight or nine people in the room.

* Paper read before the Royal Society of Edinburgh.

ELECTROPLATING DYNAMO.*

The electroplating dynamo differs from an electric lighting dynamo chiefly in its winding. For metallurgical work a large current of low voltage is required. For electrotyping, an E.M.F. of three to four volts is sufficient, while for nickel-plating it should run up to about six volts, and for silver plating to about five.

In a small dynamo, like the one illustrated in Fig. 1, it is impossible to secure as wide a range of E.M.F. or of current as can be realised in a larger machine, but by varying the speed and by introducing more or less resistance in

In the mortises of the studs are placed the brushes, which press lightly upon the commutator cylinder. The brushes are formed of several thicknesses of thin hard-rolled copper.

The field-magnet is wound with 12 layers of No. 18 magnet wire, and is connected as a shunt to the armature. That is to say, the terminals of the field-magnet wires are connected with the same binding-posts that receive the wires from the commutator brushes, as shown in Fig. 3.

The conductors of the external circuit are also connected with these binding-posts. When the connections are arranged in this way the current divides at the binding-

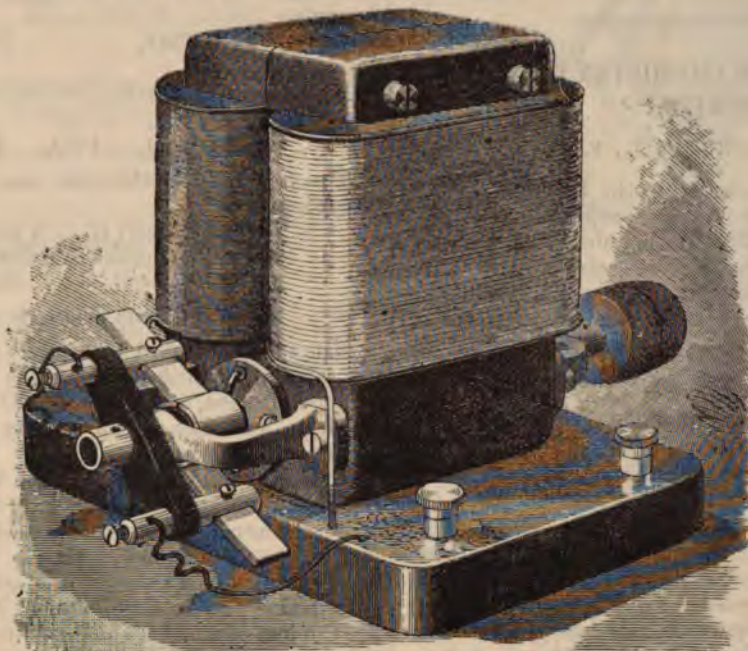


FIG. 1.—Electro-Plating Dynamo.

the external or internal circuit, the current can be adapted to most uses of the amateur. In the construction of this dynamo all of the dimensions of the cores and polar extremities of the field-magnet and of the armature core, as given in the description of the hand-power dynamo in Supplement 161 of the *Scientific American*, are followed, except in regard to the thickness of the waists of the field-magnets and their polar extremities. These dimensions are here increased by adding $\frac{1}{8}$ in. to the thickness of the waists and $\frac{1}{4}$ in. to the thickness of the polar extremities, thus increasing the amount of iron in the field-magnet.



FIG. 2.—Armature—half-size.

The armature is wound with five layers of No. 12 cotton-covered magnet wire, and the terminals of the coil are connected with the halves of the commutator cylinder as shown in Fig. 2.

The commutator cylinder is formed of two sections cut from a copper tube and mounted upon a hub of vulcanite, or vulcanised fibre, the tube sections being separated from each other so as to form diagonal slits in diametrically opposite sides of the cylinder, as shown.

The brushes are supported by mortised studs inserted in the ends of a cross bar of vulcanised fibre mounted on the journal-box of the armature shaft. The threaded ends of the mortised studs project through the cross bar to receive binding-posts which are screwed down tightly on the bar.

* From "Experimental Science," by George M. Hopkins. Munn and Co., publishers, New York.

posts referred to, a part going through the wire of field-magnet, another part going through the external circuit, which in the present case includes a plating solution.

To the negative conductor is attached the cathode or the plate or object which is to receive the deposit, and upon the positive conductor is suspended the anode or plate from which the metal for the deposit is supplied to the solution.

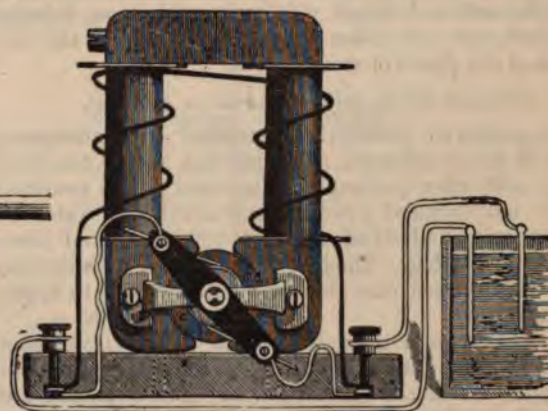


FIG. 3.—Connections.

Unless the dynamo is at first started with a battery in circuit, it will be impossible to tell, without a test of some sort, which is the positive and which the negative binding-post. This can be determined in a moment by trial in the plating solution.

If on starting the machine a deposit is made on the cathode, the connections are correct. If, however, no deposit appears, the conductors should be transposed either at the dynamo or at the plating bath.

Large wire should be used for carrying the current. Within certain limits the E.M.F. of the current may be

varied by changing the speed of the machine, and the current may be controlled by inserting resistance into the external circuit or into the shunt.

The hand-power dynamo referred to above may be converted into a shunt machine by arranging the connections according to Fig. 3, but it will necessary to introduce resistance into the shunt or field-magnet circuit to prevent too much current from going through the field-magnet.

The electroplating dynamo may be used successfully in copper, nickel, and silver plating on a small scale, also for electrotyping.

The length of wire on the armature is 40ft., and on the field-magnet about 500ft.

CONTRIBUTIONS TO THE CHEMISTRY OF STORAGE BATTERIES.*

BY E. FRANKLAND, D.C.L., F.R.S.

Under this title I communicated to the Royal Society, in February, 1883,† the results of some experiments on the reactions occurring during the charging and discharging of a storage cell. I showed that no appreciable part of the storage effect was due to occluded gases, as had been previously suggested by some chemists and physicists; but that the act of charging consisted essentially in the decomposition of lead sulphate, whilst the discharge was produced by the recombination of this salt.

The establishment of these, as practically the only reactions going on in a storage cell, enabled me to prescribe a very simple method by which the charge in any cell could be ascertained; for as sulphuric acid is liberated during the charging and absorbed by the active material of the plates during discharge, the amount of charge could at any time be measured by ascertaining the amount of free sulphuric acid in the cell; in other words, by simply determining the specific gravity of the electrolyte; and this method has since been very generally adopted by the users of storage batteries.

In continuing these experiments, it soon became evident that the lead sulphate formed and decomposed in the cell could not be the ordinary white sulphate hitherto known to chemists, because, in the first place, the active material of the plates always remains coloured even after discharge, and secondly, because whenever white sulphate is produced through abnormal reactions in the cell, it is afterwards decomposed only with extreme difficulty by the electric current.

In order to obtain some light upon the composition of the sulphate formed and decomposed in the cell, I have studied the action of dilute sulphuric acid upon litharge and minium, the two oxides of lead chiefly used in the construction of the plates of storage cells.

Action of Dilute Sulphuric Acid on Litharge.

Finely-powdered litharge was treated with successive portions of dilute sulphuric acid until the liquid remained strongly acid after prolonged trituration. The resulting insoluble buff-coloured powder was washed with water till free from acid, and dried, first at 100deg. C. and afterwards at 150-160deg. The loss at this higher temperature was less than 0.2 per cent., and was therefore due to hygroscopic moisture.

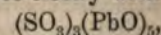
PbO and SO₃ were then determined in the dried compound as follows: The salt was dissolved in a small quantity of pure concentrated solution of caustic potash, and the solution, after dilution, was saturated with CO₂. (According to H. Rose, COPbo is soluble in CO₂, but not in COHoKo.) Any excess of CO₂, which might have caused the COPbo to dissolve, was avoided by warming the liquid with the precipitate on the water bath to a temperature at which the COHoKo begins to dissociate. The liquid was then allowed to cool and stand 12 hours before filtering. The COPbo was filtered off, converted into nitrate, and precipitated and weighed as sulphate. The sulphuric acid was determined in the filtrate from the COPbo.

* Paper read before the Royal Society.

† Proceedings of the Royal Society, vol. 45, p. 67.

1.2964 grams of the salt gave 0.6647 gram baric sulphate and 1.4437 gram plumbic sulphate.

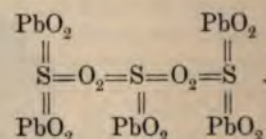
These numbers agree closely with the formula—



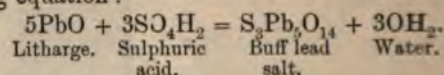
as is seen from the following comparison of calculated and experimental numbers:

	Calculated.		Found.
3SO ₃	240	17.71	17.61
5PbO	1115	82.29	81.96
	1355	100.00	99.57

These analytical results suggest the following graphic formula:



The formation of this salt may be represented by the following equation:



Action of Dilute Sulphuric Acid on Minium.

Minium was treated with dilute sulphuric acid in exactly the same way as litharge, and the resulting brownish-red compound dried, first at 100deg. C., and afterwards at 150-160deg. The loss at this higher temperature was again less than 0.2 per cent.

PbO, SO₃, and excess of oxygen were then determined in this salt in the following manner: The salt was first treated with concentrated hydrochloric acid in order to reduce all the lead to the monoxide stage. The resulting mixture was then dissolved in caustic potash and treated as already described. The excess of oxygen was determined by finding the loss of weight which resulted from the evolution of CO₂ when the salt was treated with oxalic acid and dilute nitric acid.

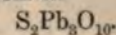
2.1136 grams of the salt gave 1.1978 grams baric sulphate and 2.2710 grams lead sulphate.

1.5110 gram treated with oxalic acid and dilute nitric acid evolved 0.0910 gram CO₂.

These numbers correspond to the following percentages:

SO ₃	19.46
PbO	79.08
O	1.09
	99.63

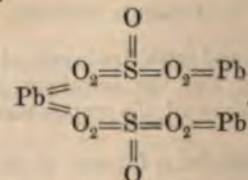
which agree with the formula—



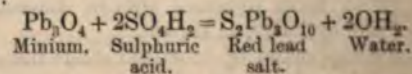
as is seen from the following comparison:

	Calculated.		Found.
S ₂	64	7.57	7.78
Pb ₃	621	73.49	73.41
O ₁₀	160	18.94	18.44
	845	100.00	99.63

The composition of this salt may be represented graphically thus:



The formation of this salt is expressed by the following equation:



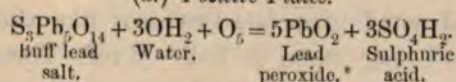
These, then are the salts which constitute the original active material of storage cells when that material is formed by the admixture of sulphuric acid with litharge or minium respectively, and it is highly probable that one or the other of these salts takes part in the electrolytic processes

of the storage battery. It is fortunate that these hitherto unknown salts (and not the ordinary known sulphate) are formed in the cell reactions; for, in the alternative case, lead storage batteries would be practically valueless.

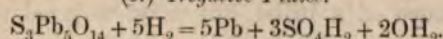
If the buff lead salt be the active material of the battery plates, then the following equations express the electrolytic reactions taking place in the cell:

I. In charging—

(a.) Positive Plates.

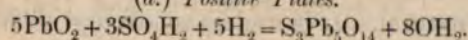


(b.) Negative Plates.

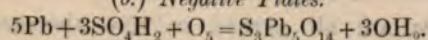


II. In discharging—

(a.) Positive Plates.



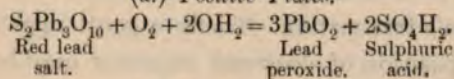
(b.) Negative Plates.



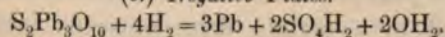
If the red lead salt be the active material, then the following equations express the same electrolytic reactions:

I. In charging—

(a.) Positive Plates.

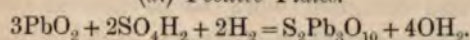


(b.) Negative Plates.

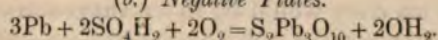


II. In discharging—

(a.) Positive Plates.



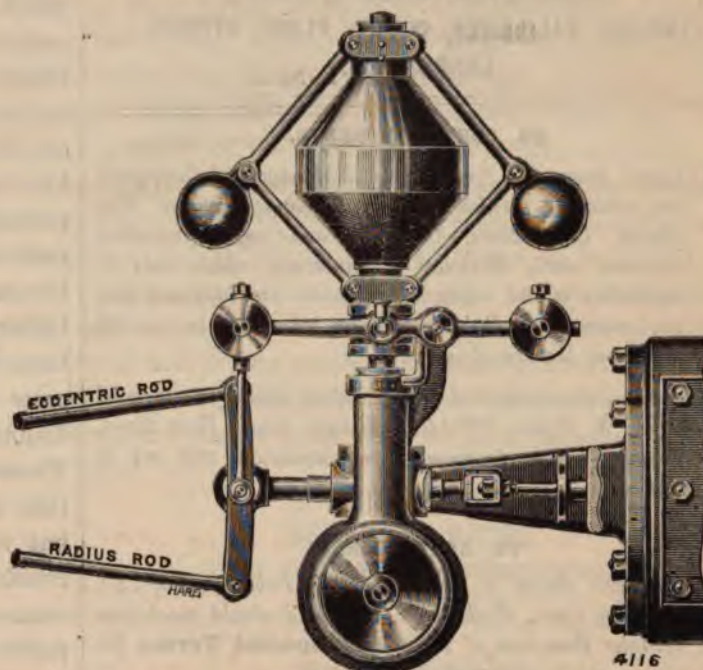
(b.) Negative Plates.



An inspection of these equations discloses, in the case of the red lead salt, a fact which has already been roughly observed in practice—viz., that only half as much active material is electrolytically decomposed on the negative as on the positive plates; whence it follows that the weight of active material on the negative plates need not exceed one-half of that upon the positive plates; for, in the decomposition of the electrolyte, equivalent quantities of oxygen and hydrogen are evolved; that is to say, two atoms of hydrogen for each atom of oxygen. But, in the decomposition of the red lead salt, four times as many atoms of hydrogen are required to reduce the salt to metallic lead as atoms of oxygen which are necessary to transform the lead of the salt into peroxide. When, however, the active material of

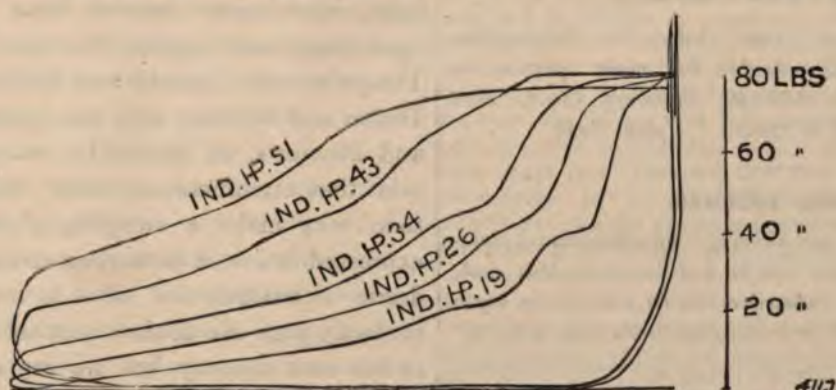
EXPANSION GEAR.

We herewith illustrate the latest development of the automatic governor expansion gear of Messrs. Ransomes, Sims, and Jefferies. We need not enter into any discussion as to the necessity for as perfect governing as possible for engines used for electric light purposes. This is well known, and every improvement will be welcomed.



Ransomes's Expansion Gear.

In this apparatus an independent gridiron expansion valve, working upon the back of the main slide valve, is operated through a knuckle joint by a link, one end of which is actuated by the cut-off eccentric, while the other end is held by a radius rod. The travel of the valve and the point at which it cuts off are governed by the position of the link in relation to the knuckle joint, and this position is varied in accordance with the load on the engine by a powerful and sensitive governor to which the link is connected. By this arrangement the cut-off can be varied between 0 and 70 per cent. of the stroke in proportion to the actual load for the time being on the engine, and the exact amount of steam necessary to do the work required being admitted at full boiler pressure up to the point of the cut-off, the entire benefit of the principle of



Indicator Diagrams taken from a 10 h.p. Nominal Portable Engine fitted with Ransomes's Expansion Gear.

the positive plate has once been converted into peroxide of lead, it seems probable that the red salt only is formed; at all events until the discharge at high potential is nearly completed, when there are indications of the production of the buff-coloured salt. But this is a point requiring further investigation.

I have to thank Dr. F. R. Japp, F.R.S., for his assistance in the analytical work of this investigation.

* Mr. Fitzgerald considers that this peroxide is hydrated.

expansion is obtained, and, in cases where an engine is required to work under varying loads, a very considerable saving in the fuel consumed is effected. The value of the wide range in cut-off obtained will be appreciated when it is stated that if the cut-off is effected at 70 per cent. of the stroke, the horse-power given off by the engine will be equivalent to about four times its nominal horse-power. It is said that the variation in the number of revolutions, when using this gear, in no case exceeds about 2 per cent.

THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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Specimen copies of the paper will be sent on request.

THE OTHER SIDE.

Prof. S. Thompson seldom gives expression to his thoughts without creating interest in the minds of many who read or hear. Last week we referred to a letter of his which appeared originally in the *Times*, and which contained indication of something which had acted upon the Professor like the proverbial red rag upon a bull. Prof. Thompson thought an expression made in a letter to him was in the nature of a bribe, but after a good deal of consideration we are of opinion that nothing of the kind was intended, and that the expression was perfectly natural. It is useless to attempt to discuss such a question from an abstract point of view, because we are all agreed in the abstract that bribery and corruption are evils to be fought at all hazards. The difficulty, however, is in the concrete to determine what is bribery. It is extremely doubtful if "bribery" can be traced in Prof. Thompson's transaction. Briefly, a gentleman writes that the position of electrical engineer may be his, but with a proviso that in the actual work engines, constructed by a certain firm, must be used. It seems to us that if Prof. Thompson had accepted the position, and designed work to be carried out, he would have specified engines to perform certain work, and his duty would be to see that such engines were supplied. His letter practically states that he is the only man who knows about engines; that his dictum is infallible, and that in Colchester, if he says so, Fowler's engines are to be used; in Leeds Paxman's engines; Gainsborough is to be supplied by Willans, and Thames Ditton by Marshall; Robey is to supply Ipswich, and Ransomes send to Lincoln; Ruston, Proctor, and Co. must not supply engines to work at home, but may somewhere else. What ridiculous nonsense this is. If the good people at Ipswich are going to have the electric light, what more natural than they shall insist upon Ransomes' engines, the same with Leeds and Fowler's, with Lincoln and Robey's, with Thames Ditton and Willans, with the birthplace of Ruston and Proctor's, of Marshall's, and so on. It will be said that circumstances alter cases. Just so, but then why make a sweeping condemnation of an expressed desire, if in certain circumstances such a desire is natural, and what is more than natural, perfectly just. No doubt a prophet is without honour in his own country, but we are sufficiently cosmopolitan to say that does not apply to engines. The mere fact that there exists in a town large works with a universal reputation for the building of engines shows that a fair number of users look upon these engines as superior, for some reason or other, than other engines brought before their notice, and hence initial cost, and cost of maintenance being somewhere about the same, there seems to be no valid reason why engines made on the spot, which

comply with the requirements of the case, should not be obtained. This, perhaps, shows that we have missed the point of Prof. S. Thompson's letter. Perhaps so, but what then is the point? Where does bribery come in? The engineer's employers certainly have something to say in the matter, and they say a certain firm is to be employed. What has that to do with Prof. Thompson? He says what the engines are to do, and how they are to be built. His conditions are followed. He does what he is paid to do, but it seems also he wants to do what he is not paid to do, and because he is not permitted in this direction, he dubs the action bribing. His letter to many partakes the nature of a conundrum, wherein we are asked to find something which, like the will-o'-the-wisp, continually eludes our grasp. We are prepared to sketch two or three methods of lighting, to mention a half-dozen firms of engine-builders, and to defy Prof. Thompson, or any other consulting engineer, to say which would turn out the most satisfactory engines. It does not much matter whether you want fast speed direct-driving engines, or slow speed, fixed, or semi-portable; you have several choices, each, according to its believers, better than the others, but which in the eyes of the cool-headed, yet competent, lookers-on are all much of a muchness. Prof. Thompson has not hit a blot which threatens our industry. Engine-makers can and do make engines almost as perfect as we ask for, and under conditions we have stated it is perfectly natural to restrict the consulting engineer to the home makers.

Let any reader who understands the subject at all, and by this we mean understand from practical experience, examine the causes of failure he has come across. He will probably find that at least 60 per cent. arise from bad wiring, and a closer examination will tell him that wiring is carried out under the worst possible conditions for success. In the first place it is generally looked upon as a minor detail, work which anybody can carry out, and which is sure to be all right with a little supervision. The cost of wiring per lamp fluctuates between 8s. 6d. and 42s. for the same class of work. That is, some firms will tender to do a job at 8s. 6d. per lamp, while others, for the same work, will want to charge 42s. Something is wrong in such cases, which are unfortunately by no means infrequent. One is probably trying to work as much too low as the other is too high, but there is the specification, and the work is of course done at 8s. 6d.—the result failure after failure, and soon the place has to be rewired at a respectable cost. If we are correct, and more faults arise through bad wiring than from any other cause, surely it is high time closer attention was given to this "minor detail." The engineer, however, is often too much impressed with the value of the engines and dynamos

to trouble himself much about wiring, switches, and cut-outs. Some of these accessories are a sight for gods and men, after seeing which the wonder is that failure is not writ larger and oftener. The experience of those who have had consignments abroad would be valuable, and might open the eyes of some people to the why and wherefore of orders not being repeated but going elsewhere. We occasionally laugh at those ignoramuses who parade so loudly the stereotype phrases about the uncertainty of the light, but it is always necessary to safeguard oneself with, it is certain *when the installation is properly carried out*. That cheap-jacks will exist just as long as folks are found to be gullible is certain, and little can be done to avoid the evils they bring in their train except to constantly point out that failure results from their employment, and, in the long run, the cost of the installation is greater than it would have been if done properly at the first.

NEW YORK NOTES.

(FROM OUR SPECIAL CORRESPONDENT.)

New York in the Dark.

The Illuminating Companies and the Board of Electrical Control in Court.

Mr. Edison on Insulation.

A Proposal to Abolish High-Tension Currents.

The Board of Health Propose to Act upon it.

"Expert Tests" by the Board.

The Electrical Commissioners and the Subway Question.

The Inquest on the Death of Feeks.

Amalgamation of Electric Companies.

Mr. Lockwood's Notes on Electrical Affairs Abroad.

The Electric Club.

NEW YORK, October 18, 1889.

As I predicted last week, the death of Feeks, the Western Union lineman, has aroused public opinion to a remarkable degree, if we may judge from the floods of sensational matter poured forth upon the breakfast-tables of the readers of the daily press. The immediate result of the latest accident, and the publicity which surrounded it, has been to leave the greater part of New York in almost total darkness, as the two largest illuminating companies, the Brush and the United States, shut down their plants on Monday pending further developments. What the ultimate results will be it is difficult to predict in the present complicated state of affairs. The Board of Electrical Control have held various meetings which were notable for more than the usual amount of fruitless and aimless talk and bickering between the Mayor and his associates, but no particular plan of action was decided upon. The principal reason for this, apart from the fact that the Board—as at present constituted—is "a house divided against itself," is that the principal companies are provided with injunctions to prevent the Board from forcibly removing the overhead wires until subway accommodation is provided. The injunctions are being fought by the city against the companies in the Supreme Court, and the argument will probably not be concluded and a decision reached for some days to come. Meanwhile the companies, in defiance of the Board's resolution that no more overhead wires are to be erected, have had a large force of men at work in all parts of the city taking down old wires and putting up new ones, so that the lighting may be resumed if the injunctions are upheld. Mr. Wheeler, the expert to the Board, has also been at work with his men, cutting down wires which showed any signs of defective insulation.

To add to the general confusion, Mr. Edison, in an interview printed in one of the daily papers, states that it is impossible to insulate a wire carrying a high-tension current. He says: "There is no insulation which will make an electric wire safe. When under ground, the high-tension

wires will burn out the tubes, the dangerous current will creep into your houses, and will come up the manholes. There is one way, and only one, in my opinion; that is, to regulate the tension under similar police regulations to those governing the pressure on steam boilers

As for insulation, there is no insulation in the world which will remove the danger." Mr. Edison confirmed these remarks in another long interview. He cited the Atlantic cables as "the highest case of insulation known," and said that the rule of cable electricians is to use the lowest pressure possible, never exceeding 40 volts, in order to avoid injuring the insulation. A comparison between a submarine cable two thousand miles long and electric light conductors is a somewhat remarkable argument to make use of, as the conditions are so very widely different. In this second interview he advocated legal measures to enforce the restriction of the tension of electric lighting or power currents to 700 volts for continuous current and 200 for alternating current. Such a regulation would leave the field pretty clear for the Edison Company.

By way of making confusion worse confounded, the Board of Health has come forward in the matter, and, in view of the enforced inaction of the Board of Electrical Control, owing to the injunctions with which the companies have provided themselves, has thrown itself headlong into the *melée*. The Board proposes to condemn the high-tension wires as a nuisance, and also incline to adopt Mr. Edison's suggestion as to framing regulations limiting the pressure to be used with the alternating current to 250 volts, and with the continuous to 700 to 800 volts. We are assured, in the daily papers, that members of the Board visited one of the electric lighting stations and made a series of "expert tests of voltage and leakage." The tests showed too great a voltage and a leakage of 1,500 volts in an alternating current! We are not told whether the experts caught the leaking volts in a pail and measured them on the spot, or whether they took them home to count them at their leisure. The average reader would no doubt have thought that extreme carefulness had been shown if the latter course had been adopted. It was not stated whether any amperes escaped through the same leaks, probably the holes were not large enough.

One of the remarkable features of the last few meetings of the Board of Electrical Control which has gone a long way towards removing any remnants of respect for that peculiarly constituted body which may have been retained by the too-indulgent public, is the scandalous attitude of the three commissioners with regard to the subway question. As I wrote last week, a representative of another company offered to build subways, and the electric light companies are anxious to build their own subways, and even offer to rent them to other companies at rates 25 per cent. lower than those charged by the monopolist company. The Mayor, on consulting with the Corporation counsel, found that the Board has the power to make contracts for building subways with more companies than one. It is estimated that from 80 to 100 miles of subways will be required, and the Subway Company has only built from 12 to 14 miles in three years. The Mayor offered a resolution aiming at the abolition of the Subway Company's monopoly and the dividing up of the work between the different companies. The resolution was defeated, however, after a long discussion, the three commissioners voting against it. It is within the bounds of possibility that the keen interest which they display in upholding the monopoly is not altogether unconnected with a more substantial kind of interest bearing a direct relation to the continued prosperity of the company and its freedom from competition. By the way, during the discussion on this subject one of the commissioners summed up the work of the Board in a sentence with which many will agree, although probably the commissioner did not really mean what he said, which was this: "We have been fooling along here for three or four years, and have done nothing."

The inquest on the death of Feeks was commenced this morning, and will probably continue for several days. The witnesses examined testified that all the wires on the pole where Feeks was killed were telegraph and telephone wires, and that an examination of the wires after the accident

failed to reveal any contact with those belonging to electric light circuits, it being believed that the contact, which must have existed, was removed by employes of the electric light companies before the linemen detailed to make the inspection reached the spot. Next week, expert testimony will be taken by the coroner as to insulation and other theoretical questions, and, among others, Mr. Charles Cuttriss, electrician to the Commercial Cable Company, will give evidence.

The latest news in the way of combines among electrical companies is that the Thomson-Houston Company has purchased the entire business of the Brush Electric Company, of Cleveland. The price is said to be 3,500,000dols. The Thomson-Houston Company also recently purchased the Bentley-Knight electric railway system, the Bentley-Knight Company having failed. Another combination has taken place in New York, the United States Illuminating Company, which is leased by the Westinghouse Company, having absorbed the Brush Illuminating Company. The name of this new combination is to be the Safety Electric Lighting Company, which, in view of the recent accidents, seems somewhat of a misnomer.

At last Tuesday's meeting of the American Institute of Electrical Engineers Mr. T. D. Lockwood read a most interesting paper, entitled "Electrical Notes of a Transatlantic Trip." Mr. Lockwood, although an Englishman by birth, has lived in America since he was 16 years of age, and had not visited his native country for 24 years when he started on his recent holiday. He spent most of his time in England, and made occasional runs over to France and Belgium, but his paper chiefly dealt with electrical matters in England. He expatiated considerably on the immensity of the central telegraph office at London; he had a respectful opinion of the operating-room of the Western Union in New York, but that of the Post Office was a decided revelation to him. He considers that the average speed of transmission in England is not quite equal to that attained here, and finds the cause in the heavy keys used by the Post Office Department. Mr. Lockwood described the outdoor construction work in Great Britain and elucidated its workmanlike and substantial appearance. He enjoyed Mr. Preece's hospitality (what representative American electrician visiting England does not?), and admired the electric lighting of his house, and he inspected Sir David Salomon's laboratory, and waxed enthusiastic over the description of the appurtenances with which it is furnished. The absence of central station electric lighting he thought remarkable, and he could not find very much in the way of electric railways. In speaking of telephony, Mr. Lockwood said that he was surprised to find that there are about 7,000 subscribers in London. He praised very highly the working of the telegraphs in England both as regards economy and efficiency, as well as the extension of the service to the most unimportant localities—he said he found no place too small for a telegraph office.

The discussion was largely contributed to by Mr. G. L. Addenbrooke, who was in New York for a few days while on his way home from Australia. Mr. Addenbrooke gave a lengthy description of the methods employed in overhead construction in England, and also gave a detailed description of the insulation used for electric light mains and the system of inside wiring. Mr. Addenbrooke's remarks were somewhat lengthy, as he actually said as much, if not more than, the reader of the paper before the meeting; but his remarks were followed with great interest by all present, and formed a valuable elucidation of some of the points touched upon by Mr. Lockwood, as well as giving information on others not mentioned by that gentleman.

Last night the Electric Club held its first meeting of the season, and a large gathering was present. Prof. Waldo delivered a highly-interesting lecture, which embodied many valuable suggestions tending to add to the popularity of the club and enlarge its scope both as a social and a scientific body. The establishment of a library was advocated, and it was also suggested that the club should, after the fashion of the Cobden Club, attract the attention of the young blood by offering prizes for competitive papers on subjects connected with electricity, to be written by students and young men engaged in practical work. Many other excellent ideas were put forth, and the meeting unani-

mously resolved to refer all of Prof. Waldo's suggestions to the committee to be reported on at the next meeting.

IMPROVEMENT IN PRIMARY BATTERIES.

Just as in the steam-engine the difference between the energy in a pound of coal and that obtained on the brake is very great, so in primary batteries the theoretic energy in a pound of zinc and the energy obtained for practical use are two different things. Anyone, then, who improves an engine or a battery so that waste may be prevented, is a benefactor to his species. We have no intention of entering into the value of primary batteries for this or that purpose, or whether they have any value at all, or to discuss the merits of one battery over another. Our purpose is to point out that Mr. Harris has improved the construction of the nitrate of soda battery, and rendered it probable that it is now as good as it is possible to make it. Hitherto, the troubles with this battery have been many and serious; some remain and cannot be avoided, others have been remedied. Mr. Harris gets rid of all intermediate contact screws by connecting his elements in series at the bottom instead of at the top of the cells. The contacts cannot possibly be corroded. A carbon-zinc couple in a solution of nitrate of soda and sulphuric acid forms the element. The porous jar and the carbon rod are rigidly fixed in position, the latter going through the bottom of the battery, and good contact being obtained by an electrolytic deposition of copper. Mr. Harris seems to have worked at the improvement of this battery with a view to provide a portable lamp. A four-cell battery, weighing, charged, about 5½ lb., will supply current to a 2½-c.p. lamp for 12 hours, and great ingenuity has been shown in adopting lamps with this battery for use in magazines, in mines, by firemen. Of course the lamps have their value, independent of that of the battery. In order to render the latter non-fuming—and all know how objectionable any nitric acid, nitrous acid, or nitrous oxide compounds are—bichromate of soda is added to the solution in such proportion as to neutralise the possibility of objectionable fumes.

THE MANUFACTURE OF THE ALLOYS OF ALUMINIUM IN THE ELECTRIC FURNACE.*

BY JOHN H. J. DAGGER, F.I.C., F.C.S.

(Concluded from page 317.)

The following gives the density of these alloys compared with other metals and alloys:

Metal.	Density.	Metal.	Density.
Aluminium bronze, 3 p.c.	8.69	Iron	7.80
" " 4 p.c.	8.62	Nickel	8.57
" " 5 p.c.	8.37	Silicon	2.67
" " 7.5 p.c.	8.00	Platinum	21.50
" " 10 p.c.	7.69	Gold	19.30
" " 11 p.c.	7.23	Lead	11.40
Brass	8.38	Silver	10.50
Cannon bronze	8.23	Copper	8.90
Cast	7.20	Tin	7.50
Cast steel	7.71	Zinc	7.10

The standard "A" grade, containing 10 per cent. aluminium, behaves as a true alloy—that is, will not liquefy into different combinations. It resembles pale gold in colour; its tensile strength in castings runs from 75,000 lb. to 90,000 lb. to the square inch, with from four to 14 per cent. elongation.

The following is the report of a test of 10 per cent. bronze produced by the Cowles process, made by Prof. Unwin, and alluded to in his work on the "Testing of Materials of Construction," p. 348.

The bar was 0.499 in diameter, and was placed in shackles which have spherical bearing surfaces, so that the tension was extremely uniform on the section: Breaking weight 7.195 tons = 36.78 tons per square inch 86,743 lb.; elongation in 10 in. 3.326 in. = 32.26 per cent.; contraction of area 0.078 in. = 39.87 per cent.; elastic limit 3.47 tons = 17.74 tons per square inch.

* Paper read before the British Association at Newcastle-on-Tyne.

The elongation in different parts of the bar was much more uniform than with iron or steel.

One inch lengths measured after fracture.

No.	1	2	3	4	5	6	7	8	9	10	11	12
	1.27	1.27	1.26	1.28	1.27	1.26	1.28	1.29	1.34	1.36	1.44	1.44

The high elastic limit in a material so plastic is noteworthy. In resistance to compression, this metal equals the best cast steel; its transverse strength, or rigidity, is about 40 times greater than ordinary brass; its limit of elasticity equals steel of the same tensile strength and elongation. Forged, tempered, and annealed, its elongation equals the best grades of steel of the same strength.

The "special" grade contains more aluminium than "A" grade; is higher in tensile, transverse, torsional strength and elastic limit. Its elongation is less, ranging from nil to 8 per cent.

The following was a test made at Washington Navy Yard, of metal of this grade supplied by the Cowles Company's works.

Test at Washington Navy Yard of Cowles Company "Special Grade" Aluminium Bronze.

Specimen.	Dimensions of specimens.		Weight applied in lb.	Elastic limit per sq. inch on original cross-section.	Weight per sq. inch on original cross-section.	Elongation per cent.	Reduction of area per cent.
	Length in inches.	Diameter in ins.					
No. 1*	2.00	.500	22,485	lb.	lb.	0.45	0.00
No. 3	2.00	.501	21,650	79,894	114,514	0.05	2.39

* Cu. 89. Al 10. Si 1.0 = 100.

Ordnance Office, Navy Yard, Washington, February 16, 1886.

A. H. M'CORMICK, Commander U.S.N., Inspector of Ordnance.

Test made in Leeds, England. The Leeds Forge Company, Limited, Testing Department. "Special Grade" Aluminium Bronze, November 10, 1886.

Specimen.	Dimensions in inches.		Tensile strength in tons.
	Diameter.	Area.	
1 round bar casting	.285	.0646	57.27 (123,400 lb.)

For the Leeds Forge Company,

(Signed) SAMPSON FOX, MAY, AND CO.

The B, C, D and E grades, containing 7½, 5, 2½, and 1½ per cent. aluminium respectively, decrease in tensile strength from about 65,000 per square inch in B, to 25,000 lb. in E grade. The transverse and torsional strength, elastic limit, and resistance to compression decreasing as the aluminium is lowered, elongation increasing in the same proportion. The E grade metal will stretch nearly two-thirds of its length before rupture, which exceeds that of pure copper by about 100 per cent. A piece of C grade wire can be twisted through several hundred turns before breaking. A rolled bar of C grade (5 per cent.) tested at the Phoenix Works, Rohort, Germany, gave:

Tensile strength... 82,880 lb. to sq. in.—37 tons.
Elongation... 60 per cent.

Average strength in castings:

Grade.	Tensile strength, per sq. inch.	Elongation.
"A" special (11 p.c.)	90—100,000	0—8.0 p.c.
"A" bronze (10 p.c.)	75—90,000	4—14 p.c.
"B" " (7½ p.c.)	55—65,000	20—40 p.c.
"C" " (5.5 p.c.)	35—45,000	30—40 p.c.
"D" " (2½ p.c.)	30—35,000	40—50 p.c.
"E" " (1½ p.c.)	25—30,000	40—55 p.c.

All grades of this bronze under 11 per cent. can be rolled, swaged, or drawn cold, and is the only bronze that is not "hot short," and can be worked at a bright red heat as easily as wrought iron. Under the hammer it can be drawn out to the fineness of a needle.

The rolling of sheets, rods, bars, and wire is done at bright

TESTS OF ALUMINIUM, BRONZE, AND BRASS.
(United States Navy Department Tests.)

Mark or No.	Approximate composition.					Length between reference marks, inches.	Diameter in inches.	Area in square inches.	Tensile strength lb. per square inch.	Elastic limit lb. per square inch.	Elongation per cent. in 15in.	Reduction of area per cent.	Diameter at fracture inches.
	Cu.	Al.	Si.	Zn.	Sn.								
Aluminium, bronze, or brass.	1c	91.5	7.75	0.75	...	15	1.875	2.7612	60,700	18,000	23.200	30.7	1.56
	7c	88.66	10.	1.33	...	15	1.875	2.7612	66,000	27,000	3.800	7.8	1.80
	9c	91.5	7.75	0.75	...	15	1.875	2.7612	67,600	24,000	13.00	21.62	1.66
	10c	90.	9.	1.	...	15	1.875	2.7612	72,830	33,000	2.40	5.78	1.82
	11c	63.	3.5	0.33	33.33	15	1.875	2.7612	82,200	60-73,000	2.33	9.88	1.78
	11d	63.	3.33	.33	33.33	15	1.900	2.840	70,400	55,000	0.40	4.33	1.86
	13c	92.	7.5	0.5	...	15	1.875	2.7612	59,100	19,000	15.1	23.59	1.64
	9d	91.5	7.75	0.75	...	15	1.900	2.840	53,000	19,000	6.2	15.50	1.75
	10d	90.	9.	1.0	...	15	1.890	2.810	69,930	33,000	1.33	3.30	1.86
	13d	92.	7.5	0.5	...	15	1.930	2.930	46,550	17,000	7.80	19.19	1.73
	1	88.	...	...	2.	10.	1.875	2.7612	18,000	10,000	2.50	4.70	1.83
	2	88.	...	...	2.	10.	1.875	2.7612	24,590	11,000	8.20	6.80	1.81
	3	88.	...	...	2.	10.	1.875	2.7612	22,500	11,000	5.80	10.89	1.77
	4	88.	...	...	2.	10.	1.880	2.7760	23,000	13,000	4.00	10.36	1.78
	5	88.	...	...	2.	10.	1.880	2.7760	20,570	13,000	2.33	6.30	1.82
	6	88.	...	...	2.	10.	1.880	2.7760	23,750	13,000	3.70	7.30	1.81

TESTS OF HARDNESS OF LARGE BARS.
(Aluminium, Bronze, or Brass.)

Mark.	Hardness of head.	Hardness of stem.
1c	9.39	13.85
7c	14.12	14.26
9c	11.18	13.59
11c	14.69	10.60
10d	17.08	16.07

HARDNESS OF NAVY YARD BRONZE.

Mark.	Hardness of head.	Hardness of stem.
No. 1	3.33	3.33
No. 5	3.67	6.56

The Navy Yard bronze was furnished by the United States Government, and carefully cast at New York Navy Yard, under inspection of an officer detailed for that purpose.

WILLIAM H. HARRIS,
Chief Engineer, U.S.N.

heat, only the finishing done cold. Rolling or working this metal in any way makes it stronger and tougher. A "rolled" rod, "B" grade, tested at the Otis Iron and Steel Works, Cleveland, Ohio, showed tensile strength 83,000lb. to the square inch, with 39deg. elongation before breaking. In the casting this metal had but 60-65,000lb. tensile strength with 20deg. elongation.

The fracture of the special and "A" grades exhibit a crystalline structure; the lower grades are extremely fibrous.

The beautiful colour, and power of resisting corrosive influences, make aluminium bronze valuable in art metal work.

In the church of St. Germain, Paris, are twelve beautiful candlesticks, 6ft. high, and a crucifix 4ft. to 5ft. in height, made of 5 per cent. aluminium bronze; these have been in position over 20 years, and their colour is still perfect. In Philadelphia the statue of William Penn, intended to surmount the dome of the new City Hall, will be cast in aluminium bronze.

Aluminium brass is another valuable alloy made by combining aluminium bronze with zinc in different proportions. It is a close-grained, homogeneous, and tough metal. The torpedo shell before you is cast from this metal (the No. 2 grade).

Al. brass.	Tensile strength in castings.	Elongation.
No. 1	23-27 tons per sq. inch	10-14 p.c.
No. 2	30-34 tons	6-11 p.c.

This alloy forges hot, and its special casting properties, its resistance to corrosion, its low specific gravity, render it valuable as a material for ship's propellers, stern and rudder frames, pump plungers and rods, valves, wheels, and pinions, and for hydraulic and engineering work generally.

A number of tests were made by order of the Navy Department of the United States, of aluminium bronze and brass as compared with United States gun bronze, with favourable results.

A blade could be made of it at least one-third thinner than cast iron or any other bronze blade, and would be correspondingly lighter.

For cartridge shells these alloys cannot be equalled, their strength would enable a thinner and lighter shell to be

used, with the advantage of not being corroded by the contained explosive. The use of aluminium bronze as a material for cannon was the subject of a paper read before the United States Naval Institute in 1887. As early as 1859 a mountain gun of this metal was cast and tested by the Committee of Artillery of France, with very favourable results; the high price of aluminium being then the only thing prohibitive of its widespread use for guns.

The following are some results of mechanical tests of aluminium bronze and brass:

Compression Tests Made at Watertown Arsenal, U.S.A.

Original length, inches.	Shortened to inches.	Original diameter, inches.	Increased to inches.	Ultimate strength.	Ultimate strength, lbs. per sq. inch.	Specimens (casting).
2.00	1.705	.798	.865	80,200	160,400	"A" 1 Bronze
2.00	1.525	.798	.914	76,800	153,600	"A" 2 Bronze

Transverse Strength.

Cross section of bar in square inches.	Length between supports. No. inches.	Breaking load in pounds.	Aluminium brass No. 2, cast in sand, tested at Milton.
1	12	8,100	—

Deflection with 5,000lb. load was but .04in., and permanent set .01in., showing remarkably high transverse elastic limit, great rigidity, and elastic resilience.

Tests made to Determine Effects of Temperature.

"A" Aluminium Bronze.	Diameter.	Length.	Tensile strength.	Elongation.
Cast in sand	.330	1	116,000	5 not broken
Duplicate	.330	1	108,000	4 " "
Same bar heated to 450° Fahr.	.330	1	108,000	1 " "
Cooled to temperature of room	.330	1	109,000	" "
Heated to 450° Fahr., or possibly somewhat higher temperature	.330	1	86,000	5 bar broke.

Showing that this bronze retains its strength through a range of temperature. Aluminium brass No. 2 subject to like test broke at 29,000 and 35 per cent. elongation, with very great contraction of area. When cold the same bar resisted 85,000lb. without rupture.

Tests Made at Milton Works.

Description.	Original diameter.	Final diameter.	Original area.	Final area.	Original length.	Final length.	T S Original section.	T S Final section.	Elongation %	Reduction of area.
A...	.737	.620	.4266	.3019	3.812	4.562	37.7	53.3	22	29.2%
B...										
C...	.614	.530	.2960	.2200	5.165	5.625	37.8	50.9	9.7	25.6%
D...										
E...	.731	.400	.4196	.1256	6in.	8in.	34.3	114.6	33.3	70%
F...										
G...	1.607	.485	.2893	.1847	2.56	3.47	34	53.6	35	36%
H...										
I...	.599		.278		2.46		44.5		5.7%	10%
K...										
L...	.570				2.40		39.0 88,000 lb.		12.5%	17.6%

A, rolled No. 1; B, brass; C, rolled No. 2; D, brass; E, rolled "C"; F, bronze; G, "Hercules"; H, metal rolled hot to 1½ in.; I, "A" bronze; K, No. 2 brass; L, rolled hot from 3 square in. pillar to 1½ in. and cold to 1 in.

Aluminium Alloys.—Shrinkage per inch in 12 inches.

Aluminium Bronze.		Aluminium Bearing Metal.	
Dry sand.	Green sand.	Dry sand.	Green sand.
A 1 ½ in.	1 ½ in.	No. 1	1 ½ in.
A 2 ½ in.	2 ½ in.	No. 3	2 ½ in.
A 3 ½ in.	3 ½ in.	Silicon.....	3 ½ in.
C 2 ½ in.	2 ½ in.		
Aluminium Brass.		Aluminium Hercules.	
No. 1, ½ in.	—	No. 3, ½ in.	1 ½ in.
No. 2, ½ in.	½ in.	No. 4, ½ in.	—

Ferro-Aluminium. The alloys of aluminium and iron have long been known. They are referred to by Faraday who found 0.013 per cent. to 0.69 per cent. aluminium in "Wootz" steel. Rogers, in an article in the "Moniteur Industriel," No. 2,379, 1859, says a small per cent. of aluminium makes steel hard, strong, and brittle, a larger quantity makes it very dense, without impairing its peculiar polish or detracting from its qualities.

The influence of aluminium in small quantity on cast iron is very marked, and was last year the subject of an interesting paper by Mr. W. J. Keep in conjunction with Prof. Mabery and L. D. Vorce, of the Case School of Applied Science, Cleveland, Ohio, U.S.A., read before the American Association for the Advancement of Science, August, 1888.

Two bases were used—one a white iron, with composition Si. 0.186, P. 0.263, S. 0.0307, Mn. 0.092; the other grey Swedish iron, marked F.L.M. with Si. 1.249, P. 0.084, Si. 0.04, Mn. 0.187. The ferro-aluminium used was made by the Cowles process, and contained Si. 3.86, Al. 11.42 per cent. Each base was experimented upon separately, and at the same time a series of blank trials were made, the metals in the two series being subjected to exactly the same conditions.

The following results were obtained:

1st. Solidity of castings and prevention of blowholes.—The aluminium castings were of a slightly finer grain and of increased solidity, with 0.1 per cent. aluminium present. The resistance to dead weight was increased about 44 per cent., and to impact 6 per cent.

2nd. Does the aluminium remain in the iron after remelting?—The white base after the addition of 0.25 per cent. of aluminium was remelted six times, fresh quantities of the white base being added each time. That the aluminium remains in and improves the iron is shown by the superior and stronger castings obtained in this series even after the percentage of aluminium had become very low than in those cases where no aluminium was added.

3. The effect of aluminium on the grain.—Aluminium seems to enable iron to hold in solution all its carbon until just upon the point of solidification, when it is precipitated in a finely graphitic form. The advantage of this is the uniformity of the mass and the absence of pockets of graphite, which are generally produced when ordinary grey iron has been cooled slowly. Hence the homogeneity

and greater strength of the aluminium castings. The rapidity of cooling makes little or no difference, as the release of the carbon seems to be instantaneous, and only at the moment of crystallisation. A very little aluminium is sufficient to precipitate graphite from white iron; 0.25 per cent. rendering it perceptibly darker in colour; 0.5 per cent. more so; whilst 0.75 per cent. renders it quite grey with no signs of white. With increasing amounts up to 4 per cent., the maximum in all these experiments, the effect is the same, the castings becoming softer and greyer as the amount of aluminium increases. The presence of much silicon does not alter the matter. The grain being the same also in thin, and rapidly cooled, as in thick castings.

4. Aluminium castings are not affected by chilling. Graphite is liberated, whether the casting is cooled rapidly or slowly, with the result that the grain is uniform, and there is no chill.

5. When sufficient aluminium is present to liberate the graphite, a coating is formed on the casting which resists the sand and the heat, and prevents the iron burning the sand into itself.

6. The fineness of the grain causes them to be more easily cut than cast iron of coarser grain.

7. The presence of aluminium increases the strength to sustain a constant load, but the strength does not increase uniformly with the percentage of aluminium.

8. The increase in strength is much greater and more marked than in the preceding. Above a certain percentage the strength diminishes, due to larger amount of graphite liberated.

9. Elasticity is improved.

10. The fineness and compactness of iron containing aluminium gives less permanent set than iron equally as soft when that softness is produced by silicon.

11. The shrinkage is slightly increased with a small quantity of aluminium, due probably to the elimination of blowholes; but with 0.75 per cent., and more, it is much decreased, especially in case of wrought iron.

12. In case of the white iron fluidity is much increased; with grey base containing much silicon it is not so clear, though it is believed the fluidity is increased.

The fact that aluminium lowers the melting point of iron is utilised in the mitis castings, the invention of Mr. Peter Ostberg, of Stockholm. In making mitis castings, a very small quantity of aluminium, about 0.050 per cent. Al, in form of 7 or 8 per cent. ferro aluminium is added to the charge (about 60lb.) of wrought iron in the crucible the moment this has been melted. The fusing point is at once lowered about 500deg., and the charge becomes very fluid, and can be cast in the finest moulds. The great difference between its temperature and its fusing point gives all the time necessary for its manipulation without danger of its solidifying.

The tensile strength of mitis castings may be as high as 27 tons per square inch, with an elongation of 20 per cent.

Another alloy made in the electric furnace is silicon bronze, which, owing to its great strength and tenacity, its resistance to corrosion, combined with high electrical conductivity, is perhaps the best metal extant for electric light, telephone, and telegraph wires.

A number of specimens lent by the Cowles Syndicate Company were exhibited.

THE NEW STORAGE CAR OF THE UNION ELECTRIC CAR COMPANY.

The new railroad just built between Beverly and Danvers, Mass., was opened for traffic recently, the system employed being that of the Union Electric Car Company, of Boston.

The road is three miles in length, and is an almost continuous line of quite heavy grades and curves, there being not more than 500ft. of level track in the whole route, and some of the grades are from six to eight per cent., so that it is a piece of road to thoroughly test the efficiency of the storage battery, which is the source of power used to surmount heavy grades and make time, and show that

this method of propulsion is to be relied upon, both as to time and economy of running.

The track is built of T-rail, 40 pounds to the yard, laid on and spiked to ties two feet on centres, well tamped and ballasted. The car-house is situated at Beverly, near the end of the track, and is 90ft. long by 40ft. wide.

There are two tracks running through the car-house, laid on stringers resting on posts, and leaving a subway or pit which permits convenient access beneath the car. On each side of the tracks are charging tables, on which rest the batteries when being charged, with electrical connection between the dynamos and the tables. The tables are the same height as the floor of the car, so that the trays containing the batteries are easily drawn from the cars to their places on the tables, and pushed into the cars from them. These table circuits are controlled at the switchboard. There is an annex, 30ft. by 28ft., in which is located the power used for charging the batteries, consisting of a 35-h.p. upright boiler, a 35-h.p. Westinghouse compound engine, and a 30-h.p. Weston dynamo, with switchboard, ammeters, etc. This plant is sufficient to charge the batteries for six cars, each car having two sets, one being charged while the other is in use. With each set the car is run 40 miles, thus making the daily service 80 miles per car.

The equipment at present consists of two box cars of great beauty and finish. The trucks of the cars were built

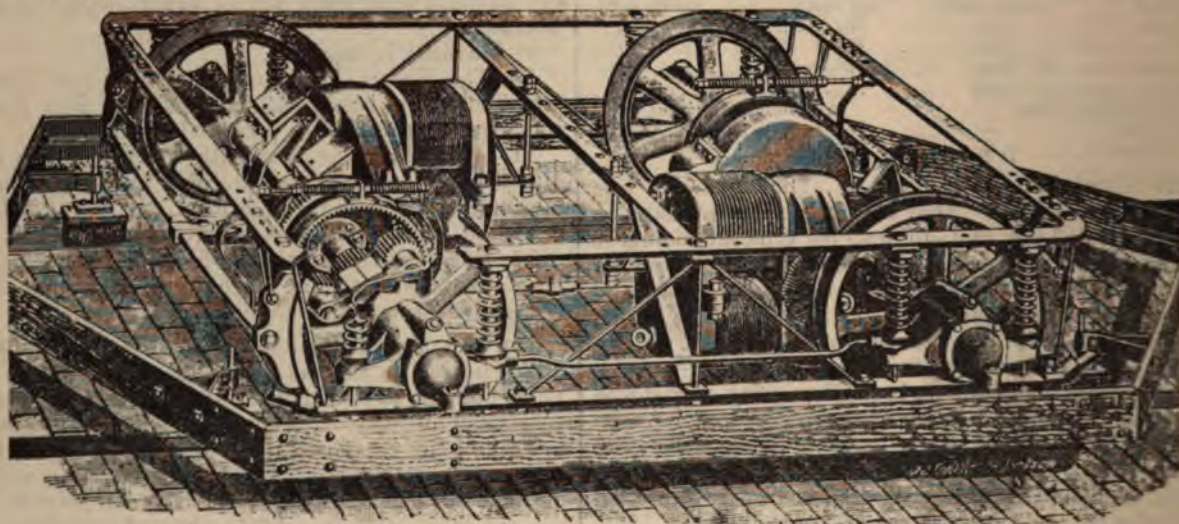
does not need to use the mechanical (hand) brake, but can brake the car with the movements of the switch handle. The charging back into the batteries, or line if it is an overhead one, in going down a grade effects considerable gain, and is shown by the ammeter used on the car to be very nearly as great in some cases as that taken in going up the grade.

The cost of equipment of this railroad with battery cars is claimed to be less than if overhead wire conductors had been used, while the running expenses will, it is estimated, not exceed one-half what they would be with the overhead system. We are informed that the management intends to publish weekly statements of all expenses, and those interested will be given every opportunity to examine the equipment.—*Electrical World*.

THE CADIZ LIGHTING.

[We have received from Messrs. Wilson and Webb the full text of the conditions of tender for the Cadiz lighting. An English translation is given below. The address of Messrs. Wilson and Webb is Antonio Lopez 2, Cadiz, and the firm will be glad to represent any English house wishing to tender, or to procure any information that may be required.—ED. E. E.]

1. The Town Council ask for tenders for the public



The Truck of the Union Electric Car Company, Beverly-road.

by the Trip Roller Bearing Company, and have their roller-bearing boxes. As will be seen in the figure, there is a motor on each axle, the armature being geared through the special gearing, patented by the Union Electric Car Company, to each axle. The dust-proof closed gear case is shown closed on one axle and the case broken away on the other to show the inside gears. These cases are partly filled with oil, so that the gear runs in a bath of oil and are almost free from friction. A description of these gears as used on the transfer table in use by the Fitchburg Railroad at their car shops has already appeared in our columns, the same system being used in both. The 138 batteries are each placed in the Huestis patent battery boxes furnished by the Newton Rubber Company, and are made of an entirely new material, taking the place of the hard rubber ones formerly used. They are placed in 12 trays, six on each side, and are placed under the seats of the cars. They are put in through the long doors let down on the outside of each car. The cars are lighted by four 16-c.p. lamps in the roof; electrical bells for passengers and conductors are placed over the seats and at each end.

One of the important features of the Union Car Company's system is the "charging-back" device with a series wound motor, thus utilising the power otherwise lost in slowing, stopping or holding the car in going on down grades, while at the same time securing perfect and complete control of the car through the switch, which is placed on the dashboard on each end of the car. The driver

lighting of the city and suburbs by electricity for a period of 25 years, dating from 26 November, 1890.

2. The service to be general, and must include under this head the entire lighting of the streets, municipal buildings, and all offices, etc., belonging to the Town Council which they should require lighting.

3. Notwithstanding what is stated in the preceding article, should no tender be received for the total lighting, but only for part thereof, the Town Council reserve the right to come to a decision without calling for fresh tenders as to what it considers best. The tender offering to light the largest number of streets at the same price per unit of light specified later will have preference.

4. The Town Council inform contractors that concessions have already been granted to Mr. F. Viesca, and to one of the gas companies of Cadiz, for the laying under ground, both in the city and suburbs, of cables for the supply of electricity for lighting or transmission of power. These concessions are for 24 years, to date from May 4 last. Mr. Viesca has already started working, having lighted a small theatre, but the gas company have done nothing up to present. The gas company must commence working before November, 1889, or loses the above concession should the Town Council decline to prolong the term.

5. The Town Council reserve the right of fixing the number and power of the lamps in the different parts of the city and suburbs, as also in the municipal and other offices belonging to them, but state as a maximum the equivalent

of 1,200 incandescent lamps of 16 c.p. (equal to 7.6 carcel) to be lighted on a daily average of seven hours.

6. The maximum price per hour per 16-c.p. lamp or its equivalent in lamps of more or less intensity, which price includes entire cost of installation, renewal of lamps, maintenance, inspection, preservation of material and labour, etc., is fixed at five centimos of a peseta approximately ($\frac{1}{2}$ d.). The lowest tender below this price to have preference.

7. In the event of a contractor supplying light for private consumption at a lower figure per light per hour than that fixed for the public lighting it must be understood that the price for the latter will be reduced to that of the former.

8. The tenders to be presented simultaneously in Madrid and Cadiz on the same date and hour to be previously published.

9. Contractors or their representatives may be present at the opening of the tenders in accordance with article 15 of the Royal decree of 14th January, 1883, for which purpose the Town Council will designate when requested the solicitor who will have to examine and approve the necessary power of attorney presented for this purpose. The parties obtaining the contract cannot transfer the rights of the same to others without the consent of the Town Council.

10. Tenders to be presented under sealed cover, and written on stamped paper of the eleventh class, and made out in strict accordance with enclosed model, those being rejected which contain erasures, alterations, or errors, the personal schedule of the contractor and receipt of the provisional deposit, to which clause No. 12 refers, must accompany the tender. Upon accepting the conditions, should the contractor desire to offer any suggestions for the improvement of same, he may do so by footnote duly signed on his respective tender.

11. The contractor for the partial lighting of the city must accept all the conditions stated, except those relating to the number of lamps to be lighted and the provisional and final guarantees, which will be fixed at 5 and 10 per cent. respectively of the total cost of the lighting during the time for which he has contracted. A plan of the city to accompany the tender showing the streets proposed to be lighted, and stating the maximum number of lamps he agrees to light.

12. In order to tender, the contractor must deposit as provisional guarantee in the treasury of the Town Council or its branches, or with the Receiver-General of deposits at the disposal of the Town Council, the sum of 191,625 pesetas (£7,665), the said amount to be raised to 383,250 pesetas (£15,330), as final guarantee by the party obtaining the contract.

13. Both guarantees may be paid in specie, in bonds of the city of Cadiz for the total nominal value, or in public funds at the legal price, in accordance with article 13 of the Royal decree of 4th January, 1883.

14. On the date, hour, and places advertised by the committee for the reception and acceptance of tenders will constitute itself in Madrid and Cadiz, the allotted time for handing in tenders being half-an-hour, during which any explanations in connection with the tenders will be duly given; at the expiration of said time the tenders will be opened, and the concession provisionally given to the most favourable proposal presented to each committee.

15. If either committee should receive two or more tenders alike, it will act in accordance with rule 11 of article 16 of the said Royal decree, and should the concession be provisionally granted to identical offers in Madrid and Cadiz, article 18 of the said Royal decree will be adhered to.

16. The concession being definitely granted, the contractor must within 10 days time complete the provisional guarantee, increasing it to the amount before mentioned, and failing to do so he will forfeit the first guarantee to the Treasury, the contract being cancelled according to article 3 of the said Royal decree, the contractor being held responsible for damages to the Municipality for non-fulfilment of contract.

17. Half the final guarantee will be returned to the contractor, should he desire it, when work has been effected to the value of said amount, the said work being previously mortgaged; and the rest of the said guarantee when the

installation is working, and upon the mortgage being increased to the full value of the guarantee. Previous to returning the first half of the guarantee, the work carried out will be duly inspected and certified as to value of same by surveyors appointed by the Municipality.

18. Contractors making deposits in the municipal treasury will pay to the chief of said department, for custody of same, 2 per mil. of the sum of said guarantee.

19. Contractors will pay all expenses originating from the contract as regards deed of guaranty, the insertion of edicts and the advertisements in the newspapers and official publications, fees to the public notary for his attendance and drawing up of the necessary deeds and legalised copy for the Municipality which may be required until final concession of contract.

20. The contractor will erect, at his expense, the works for the supply of the necessary public lighting, the same being erected, if possible, in an independent and isolated locality, observing in every case the local laws for the construction of edifices destined to the working of machinery and the regulations which the Municipality may think fit to make. The contractor may establish one or more stations, as he thinks fit.

21. Plans of the works or stations to be duly presented to the Municipality, in order to show that they contain the requisite conditions for this class of building, and to enable their being inspected by the Municipality during their erection.

22. The stations may be worked by steam, gas, or compressed air, or hydraulic power, as best suits the contractor, of sufficient power for carrying out the work, dynamos for the production of the necessary electricity, spare engine for cases of emergency, regulators for the even distribution of the E.M.F. to all parts of the city, and all necessary apparatus for satisfactory working. All stations to be open to the Municipality or its inspectors for the taking of notes, etc., etc.

23. The work of installation and distribution to commence within two months after date of final concession, and to be concluded and ready for supplying the necessary number of lights contracted for by 1st November, 1890. On this same date all plant and apparatus for the public lighting is to be ready for immediate working, trials of same being made at contractor's expense.

24. The electrical conductors from the works to the places to be lighted may be laid underground or overhead, providing that the latter be placed out of reach and proper precautions taken to avoid accidents. Cut-outs to be placed in convenient spots, and the arrangement of circuits to be left to contractor's judgment.

25. The Municipality grant the necessary permission to occupy temporarily the subsoil for the conductors, branches, joint-boxes, etc., during the term of contract, both for the public or for private lighting, but with the express condition that the latter in no way interfere with the former. As a tax for this privilege, the contractor agrees to supply the Town Council gratuitously with the necessary electricity for supplying 50 lamps of 10 c.p. each running on an average of seven hours daily for the Town Hall. The excess on this amount will be paid monthly by the Town Council at the contracted price of the public lighting. Meters for same are to be supplied at contractor's expense. Whether the cables are partially or totally overhead, he is, nevertheless, bound to supply gratuitously the amount of light above mentioned.

26. Should the gas company or Mr. Viesca obtain the concession they will pay the tax referred to in the preceding clause, being exempt during the term of the contract of 2 per cent. on the total of electricity supplied for lighting or other purposes, which they now pay for use of subsoil.

27. Should the concession be given for partial lighting the contractor will pay a tax of 2 per cent. on the amount of electricity supplied for private consumption, without including that supplied to the Town Council and paid for by them.

28. The term granted to the contractor for use of subsoil in no way interferes with those granted to the gas company or Mr. Viesca, nor grants privileges of any kind to the contractor, the Town Council reserving to themselves the right of granting as many similar concessions

relating to any other system of lighting that may be deemed convenient, or that the conditions of the town offer. The said gas company and Mr. Viesca are only obliged to take up their material in the places absolutely necessary for the installation of that for the public lighting, and only when authorised as necessary by the surveyor to the Town Council.

29. Previous to taking up the streets for the laying underground of cables, joint-boxes, and other necessary material, notice must be given to the Town Council, this work being under the immediate inspection of the municipal architect, who will, in each case, fix the depth of trenches, taking into consideration the depth of sewers and other inconveniences which might arise from the presence of the gas and water pipes or other electrical cables.

30. The contractor must observe the general regulations which the Town Council or commission appointed for the purpose necessary for the convenient carrying out of the work, and with the object of causing the least possible annoyance to the householders and facilitating public traffic.

31. All damage caused by laying cables and other plant, repairing of streets, etc., to be at contractor's expense, without any excuse being accepted on account of unforeseen accidents, etc.

32. The contractor for the total lighting will supply whatever lamps are required and asked for by the Town Council until the public lighting is complete in all suburbs, promenades, roads, etc., now existing, and any that may be constructed in future owing to the enlargement of the town, the Town Council naming the places where the lamps are to be fixed.

33. In the same manner the contractor for the total lighting binds himself to lay sufficient cables to the promenade called "Delicias," to supply the necessary fluid for any extra illumination that may be necessary during the yearly summer *fêtes* that are held, and to likewise provide conductors to the suburbs of San Jose, San Severiano, and Puntales beyond the town walls, and in the roads that lead to the said suburbs, as named by the Town Council; likewise to trench the existing quays and others that may be constructed for any increasing demands of traffic, or to facilitate the working of merchandise, for the purpose of supplying the necessary lamps that the Town Council should require.

34. As a general rule the public lighting will be done by incandescent lamps, the intensity of which to be hereafter determined. Large focusses of light, either incandescent or arc, to be installed in the squares and promenades should the Town Council think fit, and whose candle-power will also be determined by them. These to be installed either at the commencement of contract or at any future date when required. In the event of arc lamps being used their price will be previously fixed with contractor.

35. At any time the Town Council may change, at the expense of the contractor, partially or totally, the lamps installed for others of greater or less candle-power as may suit the municipal interests.

36. The contractor will provide at his own expense all conductors necessary for the distribution of the current, as also all lamps, pedestals, electroliers, supports, reflectors, etc., that may be required for the public lighting, the Town Council having the right to exact the installation of electroliers of any required number of lights in the promenades, squares, and other convenient places, the conditions of which will enable their being lighted singly or wholly as required during the different seasons of the year and at suitable hours. The Town Council may also exact the installation or focusses of incandescent or arc lamps, and of the candle-power they deem proper according to their situation, and also the number of hours they are to be lighted. All material referred to in this clause to be of the most modern construction, and are to be subject to the approval of the Town Council.

37. The entire cost of placing the material, and any expenses produced by the complete installation of the electric light, to be borne by the contractor, and all damages or injuries caused by the said operation, and also all repairs and replacements that may be necessary during the term of contract. The contractor is permitted to fix the apparatus for the public lighting on the face walls of

the houses, and will be responsible for any damage caused to same, which he will repair at his own cost.

38. The placing and changing of carbons (where used), cleaning and maintenance of the lamps, globes, supports, and shades, and that of the apparatus installed in the various clock-towers of the city, to be at contractor's expense. Once each year, in the first fortnight of June, the contractor will paint all the material placed in the public streets.

39. At the termination of the 25 years' duration of contract, all plant installed within the preceding two years for the public lighting contracted for to the Town Council—electroliers, pedestals, brackets, lamps, and focusses—as also all the apparatus, measuring instruments, and other utensils existing in the testing-room, to be established in the Town Hall, will remain the property of the Corporation, and are to be handed over, without excuse or delay, after drawing up of the corresponding inventories.

40. If upon the handing over of the plant the Town Council considers the material to be in a bad condition, or, which is the same thing, that the maintenance of same has been neglected during latter period of the contract, they reserve the right to call in practical advice in order to fix the sum in which it is considered necessary to expend for the putting in good working order of the said plant, in order that it should require no extra expenditure than the ordinary one for the continuance of its working. The sum fixed by the surveyors to be deducted from what may be owing to the contractor, or, if necessary, from the guarantee.

41. The contractor will employ and pay the staff that he considers convenient for the public lighting, management of apparatus, together with its maintenance and inspection, but sufficiently numerous for the keeping in perfect working order and state of cleanliness of the lamps, globes, shades, etc. The said staff to be supplied with proper tools and apparatus requisite for their duties, and to be supplied with decent uniforms carrying the contractor's distinguishing mark or name.

42. The light must be steady without any oscillations or intermittencies. The Town Council reserves to itself the right of inspecting and testing the public lighting at any time, and in the manner most convenient to them, and for this purpose the contractor has to instal a testing-room, with all necessary appliances, in the Town Hall. The Town Council will appoint a staff to take charge of said testing-room, and test the intensity of the light and see that the contract is properly carried out in its practical part, said staff noting any discrepancies on the part of the contractor, the Town Council acting accordingly.

43. The hours at which the lamps must be lighted and cut off will be duly fixed by the Town Council, but all must be lighted 15 minutes after the hour fixed for that purpose, the cutting off of the lamps commencing at the appointed hour. The Town Council will also inform the contractor the number of lamps that are to be cut off at midnight, those which are to remain lighted till daylight, and those which will solely be used during the summer season.

44. Should the Town Council think it convenient to suppress any of the lamps installed, the contractor to remove said lamps at his expense, and if for the convenience of lighting any changes of installations are made, same to be done at contractor's expense also.

45. The contractor must have an office in a central part of the city, likewise one in the suburbs, for any complaints that may be made, having in both these during the night sufficient staff to attend and make good immediately any faults in lighting which might be brought to his notice by the Town Council officials.

46. Should the Town Council think fit to light any offices, or dependencies, etc., under their control the contractor will supply fluid at the same rate as that stipulated for the public lighting, the contractor supplying meters, the Town Council being exempted from payment for the hire of these.

47. Both in the lighting of the Town Hall, referred to in condition 25, and its dependencies, referred to in the foregoing clause, the branch conductors, apparatus, and installation will be at the Town Council's expense, who may on their own responsibility place the contract with whomsoever they think fit.

48. The lamps which the Town Council might require

for special illuminations during festivities or public acts will be paid according to previous and special arrangement at a fixed rate, the contractor having to supply the necessary fluid at 5 per cent. less than that supplied to private individuals.

49. Within two months of the signing of the contract, the contractor must present to the Town Council detailed account and plans by duplicates, in which will be shown the number of lamp which, according to his judgment, should be installed in the different squares, streets, quays, etc., stating the power of the lamps, the columns, brackets, etc., in which lamps will be fixed, and for his guidance in making out said plans, he will take into consideration the number of gas-lamps now existing, and act in accordance with condition 5. The Town Council will examine said plans, and make any alterations they think fit, after which the plans will be returned to the contractor to commence the work necessary to open the public lighting. This is not to interfere in any way with any further partial alterations which the Town Council may make after seeing the result obtained by the installation. The contractor will be allowed 15 days to effect these alterations in the case of ordinary lamps and one month in the case of large focusses.

50. Any future improvements in this kind of lighting may be adopted by the contractor should he desire it, but always at his expense and with the permission of the Town Council, without his having any claim against the Town Council for these improvements or alterations, or for renewing of material, or difference in the price of apparatus necessary for lighting. Should the Town Council demand the said improvements to be made the contractor must effect them, in this case the Town Council paying the expenses attendant on same.

51. To avoid any interruption in the public lighting, if through some unforeseen circumstance the electric light failed any day, the existing method of lighting will remain standing for a period of three months; said period being fixed as trial, and if, during that time, it were necessary either totally or partially to make use of gas lighting, or petroleum, the expenses arising from same will be paid by the contractor; likewise will the contractor pay the corresponding fine should it be proved he were in fault.

52. The period of trial being terminated the apparatus will be removed, but should the electric light fail any day or only for a few hours the contractor must procure at his expense sufficient light of another system of lighting until the interruption is made good, the expenses arising therefrom to be paid by the contractor, being also liable to the corresponding fine for said interruption.

53. In no case will the contractor receive payment for the day or hours that the electric light may fail, even though it be substituted by another system of lighting, being liable, besides, to the corresponding fines when the interruptions arise from the will of the contractor or from negligent working of himself or staff.

54. The Town Council have the right to impose the following fines in case of failure or interruptions:

	Pesetas.
A. For each day's delay in commencing the construction of the station and general installation	250
B. For each day that passes after date fixed for opening of station during the first eight days ...	500
C. For each incandescent lamp of the usual candle-power and up to 100 c.p. that should not be lighted during the total fixed hours of lighting...	3
D. For each large focus, ditto	30
E. For each incandescent lamp of the usual candle-power and those up to 100 c.p. that should not be lighted at the proper time or goes out and diminishes in intensity before the stated time, or that may be out temporarily, and the extinction lasts for at least 15 minutes	1
F. For each large focus, ditto	10
G. For any other cause, and for not being maintained a perfect state of cleanliness the lamps, globes, shades, reflectors, etc., each light	5
H. For not being installed within 15 days any incandescent lamps of the usual candle-power, and within one month the large focusses, after being duly notified, for each delay, per day	100

C.H. For not being of the specified intensity, the incandescent lamps of the usual candle-power and up to 100 c.p.	2
I. For ditto, each large focus.....	20
J. For having laid or installed leads or cables without previously advising the Town Council.....	50

55. All fines relating to the fulfilling of the contract imposed upon the contractor will be considered as indemnities for damages, and the amount will be deducted from the monthly payment, or, if necessary, from the guaranty.

56. The Town Council will pay monthly the cost of its electric lighting, the contractor presenting triplicate accounts to the proper department in order that they may be checked and authorised by the Town Council. When the payment is delayed for more than two months the contractor will be credited interest on same at rate of 5 per cent. annually.

57. The contractor cannot solicit an increase in the price or rescindment of contract, having accepted terms of same at his sole risk, and any question that may arise regarding same, and of the understanding, compliance, and rescindment of same will be submitted to the decision of the local tribunals.

58. The Town Council may rescind the contract under the conditions established by the Royal decree of January 4, 1883. Considering as sufficient cause for such rescindment the following:

- The stoppage of the central station after what is fixed in condition 23.
- Total interruption or one-fifth part of lighting, if said interruption should occur four times in one month or six times in two succeeding months.
- Failure of intensity tested in the lamps during eight days in the space of one month or during 12 days in two consecutive months.
- Refusal by the contractor to comply in any of the conditions of this contract and without having made the reclamations to which he has a right by law against the interpretation of said condition or conditions by the Town Council.

59. If through the causes mentioned in the foregoing condition the Town Council do not determine on the rescindment of the contract the contractor will be fined, taking as a basis for said fine and for ampliation of those mentioned in letters A, B, and C, those existing in clause 54, and with respect to those stipulated in letters D and E will fine the contractor in a prudential manner, without losing the option of exacting in due form the fulfilment of what has been agreed upon.

60. In the event of the contract being for the partial lighting only, and at the end of that time it be desired to increase it to the total lighting, the contractor does not make the desired increase, the Town Council may rescind the contract, and call for new tenders for the entire lighting without the contractor having right to any indemnity whatever.

61. By giving two years' notice prior to conclusion of contract term, the Town Council may extend the term for five years, under same conditions and at the same price as existing at the date of making the extension.

62. The rules of the before-mentioned Royal decree of the 4th January, 1883, will be adhered to in everything relating to the tenders that may not be expressly stated in these conditions.

MODEL OF TENDER.

..... and Co., residing at informed of the notice and conditions of tender published in the Madrid *Gazette*, No. , of for the electric light of the city of Cadiz, engages to carry out the said service complying with all the items contained in the said conditions, and fixing as the price for the supply of electric light centimos or thousandth part of a peseta per hour per 16-c.p. lamp, or its equivalent in other lights of greater or less intensity.

Signed and dated.

Note.—The proposer wishing to improve upon the above conditions may do so subject to the approval and acceptance of same by the Town Council, binding himself at the same time to carry out any such improvements. Should a

partial lighting be proposed, the proposer must state the number of lamps.

NOTICE.

TOWN COUNCIL OF CADIZ.

It is hereby announced and put up for tender the lighting by electricity of the city of Cadiz for a period of 25 years, dating from 23rd November, 1890, in accordance with conditions of tender on view at the offices of the Directory General of Local Administration, Ministry of Government, and in the secretary's office of this Council. Said act to take place at 2 p.m. of the 25th November prox.; tenders to be presented simultaneously in the offices of the said Directorate, under the presidency of the functionary to be nominated by the Minister for the Home Government, and in Cadiz in the Mayor's office under the presidency of the Mayor or of whoever may substitute him.

Tenders to be presented under sealed cover, drawn up according to the enclosed model and on stamped paper of class II., the price reducing from five centimos of a peseta downwards for each lamp of 16 c.p. or its equivalent in lamps of greater or less intensity, and a provisional guarantee of 191,625 pesetas having been fixed to be paid by contractors to be raised as final guarantee to 383,250 pesetas.

NEW COMPANIES REGISTERED.

Birmingham Safe Deposit Company, Limited.—Registered by Herbert F. Oddy, 58, Lombard-street, E.C., with a capital of £20,000 in 25 shares. Object: to carry on the business of a safe deposit company, and also of gas, electrical, and mechanical engineers. The first subscribers are:

	Shares.
C. J. Lee, 84, Lombard-street, E.C.	1
S. H. Lee, 84, Lombard-street, E.C.	1
H. R. Butson, 65, St. Thomas-road, Finsbury Park	1
T. Brocher, 31, Ashburnham-grove, Greenwich	1
H. W. Miles, 60, Drayton-park, N.	1
G. H. Sellick, 26, Disraeli-road, Forest Gate ..	1
A. Sheffield, 12, George-yard, Lombard-street	1

Registered without articles of association.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The traffic receipts of this Company for the week ended October 18 amounted to £4,477, and those for the week ended October 26 amounted to £4,191.

Indo-European Telegraph Company.—An interim dividend at the rate of 5 per cent. per annum has been declared by the Board of the Indo-European Telegraph Company, Limited, for the first half of the current year, payable November 1.

Western and Brazilian Telegraph Company.—The receipts of this Company for the week ended October 18, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,990, and for the week ended October 25, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, £2,739.

Brazilian Submarine Telegraph Company, Limited.—The report for the half-year ended June 30 states the revenue amounted to £113,083, and the working expenses to £13,329. After providing for debenture interest, sinking funds, and income tax, there remains £85,280, to which has to be added £20,828 brought forward. A quarterly interim dividend amounting to £32,500 has been paid, and £45,000 transferred to the reserve fund, increasing that fund to £259,660. The Directors recommend a final dividend of 1s. per share, making a total dividend of 6 per cent. for the year, and also a bonus of 3s. per share, both tax free, being a distribution in the aggregate of 7½ per cent. for the year ended June 30, leaving £2,609 to be carried forward. On July 31 £14,500 was transferred to pay off the 145 bonds of the 1884 issue, drawn for redemption in April last. This repayment reduces the debenture debt to £159,500.

PROVISIONAL PATENTS, 1889.

OCTOBER 21.

16599. **Improvements in and relating to electric date and time stamps.** Charles Adams-Randall, 45, Southampton-buildings, London.

OCTOBER 22.

16648. **An improved electric railway system.** Malone Wheelless and Samuel Edwin Wheatley, 52, Chancery-lane, London. (Complete specification.)

16655. **Improvements in electric storage batteries.** William John Brewer, 4, Little Moorfields, London.

16662. **Improvements in moulds for casting the plates of secondary or storage batteries.** Waldron Shapleigh, 323, High Holborn. (Complete specification.)

16680. **Improvements in attaching or fastening telpher cables and electric light cables, telegraph wires, telephone wires, and other cables, wires and rods to insulators.** Edward John Chambers, 7, Staple-inn, Middlesex.

16709. **Improvements relating to the conversion of alternating into direct electric currents.** Henry Harris Lake, 45, Southampton-buildings, London. (Nikola Tesla, United States.) (Complete specification.)

16710. **Improvements in dynamo electrical machines.** Walter Thomas Goolden and Henry Willock Ravenshaw, 47, Lincoln's-inn-fields, London. (Complete specification.)

OCTOBER 23.

16721. **Improvements in and relating to dynamo electric machinery.** James Fraser, 8, Upper Bedford-place.

16751. **An improvement in footway kerbs with conduits for electrical conductors.** Arthur Ventris, 28, Southampton-buildings, London. (Complete specification.)

16755. **Improvements in and relating to electric lamps.** John Price Rees, 45, Southampton-buildings, London.

OCTOBER 24.

16777. **Improvements relating to switches for use in connection with telephonic apparatus.** John George Brien, 17, Paun-lane, Sunderland.

16790. **Improvements in electric safety-fuses.** Mark Ruddle, 21, Dickinson-street, Manchester.

OCTOBER 25.

16839. **An electric supply meter.** John Perry, 10, Penywern-road, Earl's-court, Middlesex.

16847. **Improved system of electric generation and apparatus.** Herbert John Allinson, 52, Chancery-lane, London. (Joseph Inglis Conklin and William Henry Rushforth, United States.) (Complete specification.)

16879. **Improvements in and connected with electricity meters.** Chaimsonovitz Prosper Eliason, 4, South-street, Finsbury, London.

16880. **Improvements in electric bells.** Leslie Watt Winnall, 4, South-street, Finsbury, London.

16887. **Means for ascertaining the state of the vacuum in incandescent electric lamps.** Frederick Herbert William Higgins, 24, Southampton-buildings, London.

16890. **Improvements in elements for secondary batteries.** Edward Frankland, Arthur Henry Hough, and Desmond Gerald FitzGerald, 47, Lincoln's-inn-fields, London.

OCTOBER 26.

16947. **Improvements in treating and rectifying or ageing alcohol or alcoholic liquors or the like by electricity.** Auguste de Méritens, 47, Lincoln's-inn-fields, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1883.

5992. **Lighting gas by electricity.** Clarke. (Complete specification.) (Amended specification.) 8d.

5926. **Electric machines, &c.** De Ferranti. (Second edition.) 1s. 6d.

1888.

14095. **Dynamo-electric machines.** Swinburne. 8d.

14322. **Galvanic cell.** Miller. 8d.

14323. **Electrolyte.** Miller. 4d.

17127. **Conduits for electric conductors.** Cliff. 4d.

17479. **Electric switches.** Nicholson and Jennings. 6d.

17590. **Secondary batteries.** Holt. 8d.

17642. **Galvanic batteries.** Moseley. 6d.

17848. **Telegraph code.** Burger. 11d.

1889.

6285. **Dynamo-electric machines.** Prentice. 6d.

11780. **Dynamo-electric generators.** Buell. 8d.

12760. **Electric motors for street cars.** Salisbury. 11d.

13480. **Charging storage batteries.** Kookogoy. 8d.

13541. **Electric wire and pole connectors.** Bonne (Mix and Genest, Limited). 6d.

13557. **Electric lamp holders.** Johnson (Collier). 6d.

13864. **Secondary batteries.** Currie. 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name	Paid.	Price Wednes- day
12 Feb.	1/2	Anglo-American Brush E.L.	—	4½
12 Feb.	2/0	— fully paid ..	—	5½
14 Nov.	0/4½	Con Telephone & Main ...	1	5
27 July	10/0	India Rubber, G. P. & Tel.	10	19½
.....	.....	House-to-House	4½	5
.....	.....	Metroptn Electric Supply	—	3½
.....	.....	London Electric Supply ...	5	4½
.....	.....	Swan United	3½	5½
12 July	12/0	Telegraph Construction ...	12	43½
2 July	6/0	— 6% 1889	100	105
... ..	...	National Telephone	5	6½

NOTES.

Lord Mayor's Carriage.—The lamps of the Lord Mayor's carriage are to be lighted by electricity.

Italy.—An electric tramway is shortly to be opened between Florence and Fiesole. Its total length will be 7,300 metres.

Newcastle-under-Lyme.—The Corporation has decided to oppose any application to supply the electric light within its area of gas supply.

Personal.—Mr. A. Bryson, a member of the Institution of Electrical Engineers, has been appointed engineer and electrician to the Edinburgh Electrical Exhibition.

Old Students' Association.—The sixth smoking concert of this association will be held at the Manchester Hotel (Aldersgate-street Station) to-morrow evening.

New Book.—"Potential and its Applications to the Explanation of Electrical Phenomena," popularly treated by Dr. Tumlriz, translated by D. Robertson, B.Sc. Rivingtons, Waterloo-place, London.

London County Council.—The Council, on the recommendation of the Fire Brigade Committee, resolved that Mr. Julius Sax's tender for the repair of the whole electric bells of the various fire brigade premises be accepted.

Glad Tidings.—Messrs. Ransomes, Sims, and Jefferies, of Ipswich, are, we find, extremely full of work in their engine department, having large orders in hand for all classes of engine work, including electric light and mining machinery.

Penzance.—At the meeting of the Council last week, it was stated that Mr. J. N. Shoolbred was a candidate for the position of consulting engineer in connection with the proposed application of the Board for a provisional order in the matter of electric lighting.

Books Received.—We have received from Messrs. C. Griffin and Co. a little pamphlet, entitled "Advanced and Honours Questions in Magnetism and Electricity, specially arranged for Teachers and Students of the Science and Art Department," by Prof. Andrew Jamieson.

Street Railways.—New street railways to be operated by electric motors are to be built at Ann Arbor, Mich.; Pierre, Dak.; Canton, Ohio; Greensburg, Pa., and Fairbandt, Minn., and the prospects are favourable that they will be built at Waterloo, N.Y., Green Bay, Wis., and Stevens Point, Wis.

Institution of Electrical Engineers.—The next meeting will be held at the Institution of Civil Engineers, 25, Great George-street, S.W., on Thursday, November 14, when a paper "On the Lighting of the Melbourne Centennial International Exhibition," by K. L. Murray, will be read and discussed.

Cardiff.—The Brush Electrical Engineering Company and the Electric Construction and Maintenance Company have written letters requesting the Corporation to reconsider the decision to oppose all applications for provisional orders to supply electricity in Cardiff. These letters were by the Council ordered to lie on the table.

Morley.—We recently paid a visit to the Springfield Woollen Mills, perhaps the largest of the mills in the

immediate district. These mills are partially lighted by electricity, the current being supplied by a couple of Phoenix dynamos. We understand that other mill owners are contemplating the use of electricity.

Wiring Tables.—We have received a copy of Woodhouse and Rawson's wiring tables mounted on rollers and suitable for hanging on the walls. We have, as yet, only cursorily glanced through these tables, but they seem to be accurate, and will be found to be of great assistance in determining the various questions relating to the distribution of current.

Personal.—We understand that Mr. Gisbert Kapp has taken offices at 31, Parliament-street. It will be noticed that they are in the district where all the consulting engineers do congregate whether they adopt one branch of the profession or another—in fact, St. George-street and its vicinity is populated almost entirely by one or other branches of consulting engineers.

Cologne.—An international exhibition of military appliances is to be held at Cologne next year. Among the exhibits are those which show the means of communication, and this position alone promises to be one of the most interesting and attractive departments of the exhibition, as here the field-post, field-telegraphy with the telephone, ballooning, the training pigeons for letter-carrying, and also the velocipede, will enter the lists.

Swan United.—The recent rise in Swan shares was justified, as will be seen from the report and balance-sheet given elsewhere. We believe this is the first dividend declared by the company, though not the first time the balance has shown a profit. We trust that six per cent. is but an earnest of future dividends, and that those who have waited so long and so patiently will be amply repaid for such waiting. We must congratulate the directors, and perhaps more especially the management, for having been so successful.

Explosion.—London has experienced the result of a collision between an electric spark and gas. Kensingtonians need not be frightened, but the gas companies will have to take particular care that the vacant spaces underneath our streets are not filled with gas leaking from their pipes, and the electric light companies must see that their leads are so laid that sparking is impossible under ordinary circumstances. Although this explosion had eye witnesses, its cause is not understood. An investigation will probably be made from which enlightenment may come.

Increased Capital.—We notice that the second issue of 10,000 ordinary shares of £5 each, at a premium of 5s. per share, and 400 debentures of £100 each, at a premium of £2, has been offered by the Woodhouse and Rawson United Company. This is the balance of the capital of the company, and is required by the directors because of the greatly increased business of a profitable character that has been offered, and this capital is required to enable the company to accept the increased business. It is stated that the premium received will be carried to a reserve fund.

Barnsley.—The new machine-shed of the Railway Foundry belonging to Messrs. Qualter, Hall, and Co., has been fitted up with the electric light. Larger lights are used for general illuminating purposes and a 16-c.p. lamp, which can be placed where required, is supplied to each workman's bench or machine. In all, there are 40 lamps of 16 c.p. and five of 200 c.p. The casting-shop is also to

be fitted. The light is being introduced into other works in the district. Thus the foundry of Messrs. William Arnold and Co. was this week for the first time lighted by electricity.

Gartnaveil, N.B.—The Royal Lunatic Asylum is to be lighted by electricity, Mr. W. A. Bryson, electrical engineer, of Glasgow, having drawn out the specification required. The installation will consist of one No. 5 Manchester dynamo for 400 incandescent lights, and one No. 3 dynamo for charging accumulators for 50 lights, to be used as a pilot circuit at night. The total number of lamps will be 370 of 16 c.p., and six large "Sunbeam" lamps of 200 c.p. each. The contractors for the work are Messrs. Anderson and Munro, and the work will be supervised by Mr. Bryson.

Hanley.—The large works of Messrs. J. and G. Meakin, Eagle Potteries, Hanley, are now illuminated with the electric light, the work having been carried out by Mr. Joseph Blackburn, Nottingham, who has also received instructions to light up the new pavilion and entrances, now being erected at Nottingham, to accommodate upwards of 12,000 people, for the visit of the Marquis of Salisbury on the 25th inst. Arc lamps will be used throughout, for which a special plant is now being put down, under the direction of Mr. W. J. Furse, the firm's engineer and manager. Messrs. Calvert and Wright are the architects and engineers for the building.

United Telephone Company v. Smith.—This case came before Mr. Justice Chitty, in the High Court of Justice, on Saturday, on motion for judgment in default of pleading by the defendant. The action was brought by the plaintiffs to restrain the infringement by the defendant of two of their patents. Counsel now asked for an injunction for delivering up the instruments, an enquiry as to damages, and an order to pay the amount of such damages. The plaintiffs also asked for their full costs, charges, and expenses, as between solicitor and client, up to and including the judgment, with liberty to apply as to future costs in chambers. His lordship made the order.

Admiralty Orders.—The Admiralty have ordered that shortly after commissioning a ship an inspection and test of all electrical fittings is to be made by the Steam Reserve and dockyard authorities in the presence of the officers of the ship and officers from the departments of the Director of Naval Ordnance and the Director of Naval Construction, (a) to ensure that everything is in perfect order, and (b) to permit the officers and men belonging to the ship to see and become familiar with the electric installation worked at its full power by the dockyard or Steam Reserve authorities, and so to prevent any conflict of opinion subsequently as to the responsibility for mishaps on actual service.

London Chamber of Commerce.—We are informed that in accordance with the following resolution unanimously passed at the last meeting of the Electrical Trades' Section, a special meeting of that body will be held at the offices in Eastcheap on Monday next, the 11th inst., at 4 p.m.: "That with a view to the electrical industry taking common united action with regard to the proposed Electrical Exhibition in Edinburgh in 1890, a committee be appointed to consider the conditions on which it may be advisable to take part in the exhibition, and that a meeting of the entire electrical section of this chamber be called for Monday, the 11th inst., to receive the report, and, if thought advisable, to take action thereupon."

Chelmsford.—The arrangements for the electric lighting of the town are progressing. One or two nights ago, the arc lamps which are to light Moulsham-street, from the top of St. John's-road to the Stone Bridge, were tested for an hour or more with remarkable effect. The light was clear and steady. The inhabitants of the courts and alleys came out to gaze, and, the children flocking into the street, the scene was a lively one. In order to make the trial complete, Messrs. Crompton and Co. had all the arc lamps which are to be used in the borough working at the same time, the eleven not yet erected being fixed in the lamp-room. The incandescent lamps, which are to be used in the narrower streets, will shortly be tested like the others.

Spanish Exhibition.—A correspondent writes us concerning the lighting of this exhibition, as follows: "Now the Spanish Exhibition is over I wish to say a few words about the electric light. From the very start to the very last hour of lighting there has not been a single hitch in one of the lights, not a single breakdown in any of the engines or dynamos, a spare dynamo having been kept in reserve and not once switched on during the whole run. There has not been one hot bearing in either engines or dynamos during the five months' run, and, taking into consideration that the Gulcher Company only had five or six weeks' notice of the lighting, having had to make every lamp and nearly every dynamo for the installation, I think great credit is due to the company, and also the way in which it was managed by the Gulcher staff."

Ireland.—At Grove House, in the county of Tipperary, Ireland, the residence of Mr. Richard Burke, the popular Master of the Tipperary Hounds, the electric light is being installed on an extensive scale. The lamps are being introduced not only through the dwelling-house, but throughout the out-offices, where are tended and cared some twenty of the finest hunters to be found in the South of Ireland, as also the kennels, etc. The installation consists of a vertical steam-engine, Elwell-Parker dynamo, and set of accumulators, the whole calculated to run about 100 lamps at a time. Electroliers of a handsome and costly character are provided for the reception and other principal rooms, and elaborately mounted switchboards for controlling the main and branch circuits. The whole of the installation is being carried out according to the specification and under the immediate superintendence of Messrs. J. K. Fahie and Son.

Edinburgh Exhibition.—Considerable progress is being made with the arrangements for the International Electric and Inventions Exhibition to be held in Edinburgh next year. On Monday last a deputation from the executive council waited upon the council of the Institution of Electrical Engineers, with reference to various suggestions connected with the adequate representation of electrical science. The following names, among others, have already been added to the London Committee, under the presidency of Sir Henry Isaacs, Lord Mayor-elect, and the chairmanship of Sir George Hayter Chubb: Sir John Lubbock, M.P., F.R.S.; Sir Henry Roscoe, M.P., F.R.S.; Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E.; Sir Frederick Abel, C.B., F.R.S.; Sir Charles Mills, K.C.M.G., C.B.; Sir Arthur Blyth, K.C.M.G., C.B.; Sir F. Wyatt Truscott; Baron de Bush; E. M. C. Braddon (Agent-General for Tasmania); Captain Shaw, C.B.; Colonel Gouraud, and Mr. W. H. Preece.

Newcastle.—It is stated that the two electric lighting companies have been unable to commence operations on account of a technical point of law, which awaits the decision of the law officers of the Crown. Until this point is settled the Board of Trade cannot grant the licenses, and, of course, meantime the companies are absolutely powerless. Both companies are quite ready to commence operations directly the license arrives. Thus far a Newcastle contemporary, but as far as we know only one of the companies is really ready to start at once. Many visitors to the late meeting of the British Association may have strolled down the street, past the reception-rooms, and if so, they would see a new building with a tall chimney shaft in front of them. This building is the electric light station of what may be termed the local company, and at the time of our visit one of the fine Robey engines was running. The dynamo, a Mordey alternator, was daily expected. This station, then, is ready to run, but where and what of the other?

An Electrical Engineer Drowned.—A sad occurrence has happened at Etruria, in the death by drowning of Mr. F. W. Neale, son of Mr. John Neale, superintendent of the telegraph department of the North Staffordshire Railway at Stoke-on-Trent. It appears that the deceased was walking along the towing-path of the Trent and Mersey Canal, between Longport and Etruria, and when opposite Earl Granville's forge he was seen to stagger and fall into the water. Several workmen ran from the forge to the canal side, but when they got there Mr. Neale had disappeared. One of the men dived into the water repeatedly, but despite every effort that could be made, over an hour elapsed before the body was recovered. The deceased, who was about 30 years of age, was an electrical engineer, carrying on business at Stoke, and he was well known throughout the district from his connection with the telephone. It is supposed that the deceased fell into the canal while in a fit, having been subject to such seizures for some time past.

Society of Arts.—The opening meeting of the Society of Arts will be held on Wednesday evening, 20th November, when an address will be delivered by the Duke of Abercorn, C.B., chairman of council. The papers fixed for reading at the Wednesday evening meetings before Christmas are as follows: November 27, "Scientific and Technical Instruction in Elementary Schools," by Dr. J. Hall Gladstone, F.R.S. On this occasion the Right Hon. A. J. Mundella, M.P., will take the chair. December 4, "Rabies and its Prevention," by Armand Ruffer, M.D. December 11, "The Paris Exhibition," by H. Trueman Wood, M.A., secretary to the society. Sir Philip Cunliffe-Owen, K.C.B., will preside. December 18, "London Sewage," by Sir Robert Rawlinson, K.C.B. We notice that the second series of Cantor lectures, to be delivered on January 20 and 27, February 3 and 10, is on "The Electromagnet." The lecturer is Prof. S. P. Thompson, who may be said to be one of the best and clearest lecturers now living. These lectures should be of the greatest interest to electrical engineers.

Water Colours and the Electric Light.—A new point to be considered in the fitting of interiors with electric light has been raised by Mr. J. J. Hissey, of Raven's Moat, Eastbourne, with reference to the actinic effect of the light upon water-colour paintings. It is well known that the strong light of the sun will cause some colours to fade, and it appears this effect is to be feared if an incandescent

lamp is hung too near to the drawing. Mr. Hissey writes: "Now that the electric light is being generally introduced into our houses, it may be as well to caution those possessing valuable water-colour paintings against placing the electric lamps in close proximity to their pictures, as I have found, after three years' experience of the electric (incandescent) light in my own home, that, so placed, the new illuminant is sufficiently powerful to cause some of the more delicate pigments to fade to a greater or a lesser degree. Water colours that are safe in diffused daylight are certainly not always so when exposed night after night, for many hours, to the active white light of electricity close at hand."

The Julien Company.—This company has issued a circular, dated New York, Oct. 26, to the effect that in view of the recent decision of Judge Lacombe, assigning to this company a definite and specific process of making its storage batteries as distinguished from other methods, they have concluded to temporarily suspend the operation of the cars in New York pending the manufacture of batteries according to the method prescribed by the court. The factory at Camden will expedite the manufacture of batteries so as to enable them within a few weeks to resume operations. "It is gratifying," says the company, "to know that the court has finally determined the respective rights of this company and the complainants as to the methods to be employed by each in making batteries, more especially as the method we shall now employ is not only practical, but, in the opinion of such competent experts as Prof. Cross, of the Institute of Technology, Prof. Brackett, of Princeton College, and Prof. Edward Weston, of Newark, is superior to the method awarded to the complainant."

Leeds.—Mr. E. Ford, on the 31st of October, applied to Mr. Justice Chitty, in the Chancery Division, on behalf of Mr. Monteith, of Leeds, for an interim injunction over the next day, with leave to serve notice of motion with copy of the writ in the action on the liquidator of an electric lighting company to restrain him from removing from the plaintiff's premises the apparatus for lighting these premises with electricity. The circumstances under which the application was made were that in October, 1888, the company entered into a contract with Mr. Monteith to light his premises electrically for five years. The company since then has gone into liquidation, and a liquidator has been appointed. This gentleman, it was said, finding the contract an unprofitable one, had determined not to continue it, and he had given notice of his intention to remove the plant that day. The premises, not having sufficient gas-lighting power, it was alleged, would be left in darkness if the electric lighting was discontinued, and on the ground that the contract of the company ought to be carried out, the plaintiff sought the relief of the court; and Mr. Justice Chitty granted it.

Indiarubber.—We have received the first number of an American contemporary devoted to the indiarubber industry, entitled *The Indiarubber World*, and among other interesting matter we find the following note on insulation: "It will necessarily be some time before all the circuits of the various illuminating companies in our principal cities are placed under ground, but meanwhile it is passing strange that the companies do not attend more carefully to the proper insulation of their overhead wires. There is an abundance of good types of insulated wires for outdoor work, and the companies have

not the excuse they had a few years back of not being able to obtain proper material at a reasonable price. The recent storm, and the removal of the telegraph and telephone wires in many streets of New York, have served to make more apparent the necessity for the reconstruction of some of the electric light circuits. By undertaking this, the companies would serve their own interests in more ways than one, and perhaps we should be spared some of the rabid writing on electrical subjects that has lately become so common in the dailies."

The "Scotsman" on Electrical Engineers.—"In scientific circles a good deal of interest attaches to the final decision of the Committee of the London Chamber of Commerce, appointed to consider what steps the electric light companies should take in relation to the forthcoming exhibition in Edinburgh. There is such a spurt in the electrical world at present that the companies seem to think they can dispense with displays at the various exhibitions held throughout the country. Something of this feeling has been manifesting itself for some time, but at last it has begun to take shape. The companies think, too, that some more consideration ought to be shown to them by the promoters of exhibitions. What they desire is practically space and power free of charge. If these are not conceded, the boycotting of the exhibitions which refuse is talked of, but in the present case it is hoped more moderate counsels may prevail, and that with a little concession on both sides all difficulty will be removed. The question has been raised in connection with the forthcoming exhibition in Edinburgh, merely because it is being promoted at a time which, in the opinion of the electric light companies, is favourable for arriving at concerted action."

High-Tension Currents.—Mr. J. T. Bottomley, writing to the *Glasgow Herald*, discusses the introduction of high-tension currents into the northern city, and states that he has a list of 91 deaths caused by electric light currents, and this is by no means complete. Most of these casualties have taken place in America, where overhead wires are the rule, and not the exception. Mr. Bottomley points out that we ought to have gained experience from American work, and even if overhead wires are permitted, the public must protect themselves by calling on those in authority to see that proper precautions are taken for their safety. Mr. Bottomley concludes his letter with the following: "It is a most serious question at the present time to what extent it should be permitted to spread a network of conductors for high-tension currents—and particularly high-tension alternating currents—through densely populated cities. Some of the highest authorities, including Mr. Edison and Sir William Thomson, are more than doubtful whether it should be allowed at all; and it is largely a matter of cost of copper *versus* comparative safety from fire and complete safety to life. In any case it is prudent that whatever is done should be done with due precautions, and with full knowledge of all who are concerned. This is the only way to avoid ultimate loss and disappointment."

Lecture on the Telephone.—A lecture of unusual interest was delivered by Mr. Alfred Coleman, general manager of the National Telephone Company, Birmingham, in connection with the Aston Free Library lectures, on Tuesday evening. The lecturer, in a very lucid and simple manner, explained the theory of sound on which the telephone is based, and illustrated his remarks with a number

of interesting experiments. An exemplification of the practical working of the telephone was also given, the platform being for the time being converted into a telephonic exchange, two instruments fixed at the lower end of the room representing the speaking stations of two subscribers. Photographs of all the principal exchanges in Great Britain were shown by the lime-light, and at the conclusion of the lecture a practical demonstration was given of the capabilities of the telephone for transmitting sounds over long distances, a cornet solo played at Bradford being distinctly heard by the whole audience in the lecture-room at Aston. The Rev. F. Smith, M.A., presided, and a unanimous vote of thanks was accorded to the lecturer on the motion of Dr. John Harvey, J. P., seconded by Mr. J. Osborne. Such lectures as these are calculated to increase the knowledge of electrical matters amongst the general body politic, and do an immense amount of good in putting information into popular language and spreading it among the community.

Groth's Electric Tanning Process.—Since the appearance of our note on this subject last week we have obtained the views of practical men upon the subject, who have long been engaged in the tanning industry. The general opinion seems to be that although leather may be obtained, it must necessarily be far inferior to that which has been obtained by the usual process, and that while there may be initial saving in the production of such leather, there will be a loss in reality because of the inferior quality produced. It is difficult for the practical man to understand where electricity comes in, and if the practical man cannot understand it, it is still more difficult for the electrician. So far as we can imagine what takes place, the current would decompose some of the solution, the gases would be given off at the electrodes, and how this assists the combination of the tanning of the bark with the gelatine of the hide is not as yet well understood. The practical opinion is that the efficacy consists in having the solution warm and keeping the hides moving, but there is nothing new in this. When the hides are first put into the pit they are frequently moved so that the outside of the skin shall not be too rapidly acted upon, and too hard for the percolation of the solution into the interior, and also that there shall be an equality of action throughout the pelt. The objection urged against hanging the skins upon radiating arms and moving them through the liquor is the inequality of the action which takes place in the lower part over and above that on the upper part. At any rate, before our electrical friends enter upon an enterprise of this kind it would be well to have far more information on the subject than is at present available. We must take the statements of inventors and promoters and the results they obtain, and see how far they agree with those of independent authorities.

Richmond (Virginia) Tramway.—Statements are going about in the American press to the effect that the financial success of the much vaunted Richmond, Va., electric railroad is more than doubtful, and it has been announced that the company will change the system or revert to horses. It seems there is a piece of financial scheming at the bottom of this matter. The road was bought up by a syndicate of New York capitalists, one of whom was a Mr. Flynn, since dead. The equipment of the line by electricity was undertaken by Sprague before the very arduous conditions were known. Nevertheless the difficulties were tackled and, as we know, overcome. The Sprague Company's

representative has made a statement upon the affairs of the tramway, and says: "Though wretchedly constructed as to track, etc., the line was at first and has ever since been, as we are informed, a financial success. That this is so, and that many of the stories told of burn-outs and troubles are grossly exaggerated, may be inferred from the statement of the gross receipts, 200,000dols. per year, which means 4,000,000 passengers per year in a city of 80,000 inhabitants. Nevertheless, that such troubles have existed far more than in other roads of equal size or less, is undeniable, and is due to the attitude assumed by the New York owners. Relying upon our interest in the maintenance and advertising value of the road, they refused to bear any part of the cost of putting the road in good condition as to track, repairs on cars and overhead structure, even going so far as to neglect to provide the cars with any shelter whatever in the way of car house; so that from the beginning up to the present time, as we are informed, there has been no way but to allow the cars to stand in open air in all conditions of weather, becoming water soaked and weather beaten. After putting a large amount of money into the road, we absolutely refused to become the victims longer of any such practice, and in hope of injuring us, matters have been allowed to drift along from bad to worse. The animus of the onslaught upon the road is the desire of the active managers in Richmond to secure control of the road at extremely low figures. They hope to do this by obtaining the interest of Mr. Flynn's estate, which is now held by his widow. The road is, in fact, a bonanza to its owners, or would be with proper maintenance and heavier apparatus, and the condemnation of electricity is but one of the methods employed to 'bear the market.'"

Bournemouth.—The Brush Company is showing commendable activity in pushing the interests of electric lighting in this favoured town. They have already established a central station, which is supplying the current to some of the leading hotels and to private houses. A few days ago a deputation from the company was received by the Lighting Committee of the Bournemouth Improvement Commissioners, to whom it was pointed out that in their work every effort was made, when the question was the establishment of central electric light stations, to examine the local circumstances and requirements and to adopt that system best calculated to answer these requirements. Here, as elsewhere, the question of overhead wires is one of importance, and it was pointed out by the deputation that the telephone companies themselves, using overhead wires, were the most active opponents to anyone else adopting such a system, and that, for example, if overhead wires were used at Bournemouth, the total number visible would represent only a small proportion of the telephone wires at present erected. After the Lighting Committee had examined the plans of the Brush Company, and obtained full information in regard to the terms of the proposed provisional order, they proceeded to the lighting station of the Brush Company in the Bourne Valley, adjacent to the Gas Works. The Brush Company have acquired the freehold of a very large plot of land, conveniently situated as to supply of fuel and water, and quite free from the objection to the site of former electric works, in so far as there are no risks of causing inconvenience or annoyance from vibration or other trouble to residents. They have erected a building covering 3,200 square feet, which will be extended to 12,000 square feet. The plant at present installed consists of two compound vertical steam-engines, designed by W. Raworth, the

engineer of the company, of 75 h.p. each, steam being supplied by two water tube boilers of 150 h.p. each. The engines drive two of the well-known Mordey Victoria alternate-current dynamos, each capable of supplying 1,000 incandescent lamps. The plant is now in use supplying light to Newlyn's Hotel, the Sanatorium, and other customers. But a larger plant is now being put down, consisting of an engine of 200 h.p. and two dynamos, each capable of maintaining 3,000 lamps of 10 c.p. each. When this plant has been erected, the present machinery will be devoted to supplying lights required during the day, so that customers may be able to turn on their electric lamps at any hour of the day or night. If necessary, the company would be prepared to put down further plant—in fact, to supply all the current required.

Birmingham.—Crowded out of our issue of last week, nevertheless it will be well to refer more fully to the trial of an electric tramcar belonging to the Birmingham Central Tramways Company, of the type recently produced by Mr. Thos. Parker, of Elwell-Parker and Co., Limited, of Wolverhampton, in conjunction with Mr. Alfred Dickinson, the consulting mechanical engineer of the company. The run was from Station-street to the Sparkbrook depot and back with a full load of passengers. A number of gentlemen interested in electrical engineering were present, among whom may be mentioned the Mayor of Birmingham, Sir Saul Samuel (Agent-General for New South Wales), Sir Daniel Cooper, G.C.M.G., Sir R. Fowler, Bart., M.P., Sir Henry C. Mance, C.I.E., Sir Douglas Fox, M.I.C.E., Alderman Powell Williams, M.P., Mr. J. Spencer Balfour, M.P., Mr. T. P. O'Connor, M.P., Colonel Twynam (chairman of the Birmingham and Midland Tramways Company), Councillor Lawley Parker (chairman), and Messrs. J. Smith and Granger (members of the Public Works Committee), J. E. H. Gordon, D. S. Hasluck (chairman of the Birmingham and Aston Tramways Company), Thomas Parker, J. B. Verity, Messrs. Smith, Neale, and Wain (directors of the company); the following officials of the Central Tramways Company: Mr. J. Kincaid, engineer; Mr. W. Holmden, secretary; Mr. Alfred Dickinson, consulting mechanical engineer; Mr. C. Harvey Herring, traffic manager; Mr. R. H. Dickinson, locomotive superintendent; and others. The company assembled being too numerous to travel by the electric car alone, a steam driven car preceded the electric car carrying a number of the visitors. The trial was regarded as highly satisfactory. The car was driven by Mr. Dickinson, and its journey was watched with great interest by crowds of spectators who assembled along the route. After the trial, a luncheon was held at The Queen's Hotel, presided over by Mr. Joseph Smith. That gentleman, in proposing the toast of "Success to the System of Electric Traction," spoke at some length of the advantages of electric over horse traction. He said that he would call upon nobody to respond to the toast proposed, as he thought electric traction was able to answer for itself. Other toasts were proposed, and, in replying, Mr. Smith stated that he welcomed the proposal referred to by Councillor Lawley Parker, to the effect that electricity should be used on other routes than Bristol-road, and said if he had not been satisfied that the enhanced profit of electric traction would pay for the abolition of steam-engines he would never have advocated it. The health of Mr. Thomas Parker having been drunk, the proceedings terminated.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The first annual dinner of the Institution of Electrical Engineers was held on Monday evening last at the Criterion Restaurant. The president, Sir William Thomson, occupied the chair, and the guest of the evening was Lord Salisbury. The dinner was well attended, every ticket having been disposed of, late applicants having to be refused. The secretary of the society, Mr. F. H. Webb, had taken the greatest pains to make the meeting a success, and he must be congratulated that his efforts were not in vain. Almost all the well-known members were present, and in every way the meeting seemed to indicate that the idea was in accordance with the feelings of the members. At the conclusion of the dinner, which was served in Messrs. Spiers and Pond's well-known style:

The CHAIRMAN, in proposing the toast of "The Queen," said that the Institution of Electrical Engineers had every reason to appreciate to the full the reign of Queen Victoria. During the lifetime of her Majesty electricity had become a science. Oersted's discoveries took place very nearly at the time when her Majesty was born, and electricity became a branch of engineering almost at the same time that the Queen came to the throne. The prosperity which had attended her reign had been shared, of all professions, most notably by those whose development had led to the existence of the Institution of Electrical Engineers.

After the toast of "The Prince and Princess of Wales" had been duly honoured,

The CHAIRMAN proposed "The Army, Navy, and Reserve Forces." He said that it seemed as if the Army and Navy were to become year by year more and more electrical. The telegraph department attached to the Army had long connected the land forces with electricity, and 30 years ago the laying of the great submarine cables seemed to indicate that an electrician, unless he were a sailor too, was almost useless. Electrical science formed the foundation of the knowledge of scientific officers of both services, and now no less than 70 members of the Institution belonged either to the Army or the Navy.

MAJOR-GENERAL WEBBER, in responding for the Army, said the application of electric science to the art of war formed an interesting subject of study. What, for instance, would have been the effect upon the tactics adopted at Waterloo if the armies of Wellington and Blücher had been in telegraphic communication. The benefits of the measure of 1870, by which two companies of Royal Engineers were sent to be trained in telegraphy at the Post Office, had been evident in every small war that this country had since undertaken. General Webber referred to the great uses of the telegraph during the American Civil War, and still more so in the Franco-German War. Huge armies are now controlled and made to act as one unit by means of the telegraph. Reference was made to the manner in which, during some of our little campaigns, the operators had to work under fire, showing that like any other soldier the soldier-telegraphist carried his life in his hands.

CAPTAIN WHARTON, in responding for the Navy, said that electrical science had played a large part in the development of the British Navy. The most important contribution of the science was to be found in the electric search lights, without which no ironclad would be safe against the attacks of torpedo boats. In ships, of all things else, the electric light was especially valuable, and it had long been adopted in the Navy. Sir William Thomson himself had done good work for the Navy, not only in regard to the laying of telegraph cables, but also in regard to his compass and his sounding apparatus.

The CHAIRMAN then proposed "Her Majesty's Ministers," the toast being received with loud cheers. He said that it was due to the action of her Majesty's Government alone that men were able to live in peace, practise their professions, and cultivate their sciences. Through the prosperity which the Government brought to the country those investigations and good works could be carried on, the pursuit of which was the object of the Institution's existence. The country ought to be obliged sufficiently to those who were willing to conduct for them the business of legislation; but how much more gratitude should the

nation feel to those who undertook the actual burden of the State? The excessive labour and responsibility they underwent was appalling. Every member of the Government had some private occupation which he would like to pursue; and what must electricians think of the man who forsook electricity for government; who might be working in all the beauties of electrical science, following them, investigating them, and making discoveries in them, were it not for the higher duty which called him to take up the government of the State in the interests of the nation? Lord Salisbury was one of themselves in the sense of being a scientific electrician and an electrical engineer. All must appreciate profoundly the honour which the Prime Minister had done the Institution in being present at its first dinner at the end of the first year of its existence.

The MARQUIS OF SALISBURY, who was received with prolonged cheering, said, in response: Sir William Thomson and Gentlemen,—I have to thank you on behalf of my colleagues in the Government and myself for the exceedingly kind reception you have given to the kind words in which Sir William Thomson has proposed this toast. I do not feel that I can accept the guise in which he put my name forward. On the contrary, though recognising, as every individual must do, and as I have especial reason to do, the enormous benefits which electrical science confers upon mankind, I feel that I have reason rather to apologise for my appearance in this assembly. When I look round on so many learned and distinguished men I feel rather in the position of a profane person who has got inside the Eleusinian mysteries. But I have an excuse. The gallant gentlemen who replied for the Army and Navy were able to show many particulars in which their special professional vocation was sustained and pushed forward by the discoveries of electrical science. But I will venture to say that there is no department under the Government so profoundly indebted to the discoveries of those who have made this science as the Foreign Office, with which I have the honour to be connected. I may say that we positively exist by virtue of the electric telegraph. The whole work of all the chanceries in Europe is now practically conducted by the light of that great science, which is not so old as the century in which we live. And there is a strange feeling that you have in communicating constantly and frequently day by day with men whose inmost thoughts you know by the telegraph, but whose faces you have never seen. It is something more than a mere departmental effect which these great discoveries have had upon the government of the world. I have often thought that if history were more philosophically written, instead of being divided according to the domination of particular dynasties, or the supremacy of particular races, it would be cut off into the compartments indicated by the influence of particular discoveries upon the destinies of mankind. Speaking only of these modern times, you would have the epoch marked by the discovery of gunpowder, the epoch marked by the discovery of the printing-press, and you would have the epoch marked by the discovery of the steam-engine. And those discoveries have had an influence infinitely more powerful, not only upon the large collective destinies, but upon the daily life and experience of multitudes of human beings than even the careers of the greatest conquerors or the devices of the greatest statesmen. In that list which our ignorance of ancient history in its essential character forbids us to make as long as no doubt it might be made, the last competitor for notice and not the least would be the science of electricity. I think the historian of the future when he looks back will recognise that there has been a larger influence upon the destinies of mankind exercised by this strange and fascinating discovery than even in the discovery of the steam-engine itself, because it is a discovery which operates so immediately upon the moral and intellectual nature and action of mankind. The electric telegraph has achieved this great and paradoxical result, that it has, as it were, assembled all mankind upon one great plane where they can see everything that is done, and hear everything that is said, and judge of every policy that is pursued at the very moment when those events take place, and you have by the action of the electric telegraph, combined together almost at one

moment, and acting at one moment upon the agencies which govern mankind, the influences of the whole intelligent world with respect to everything that is passing at that time on the face of the globe. It is a phenomenon to which nothing in the history of our planet up to this time presents anything which is equal or similar, and it is an effect and operation of which the intensity and power increases year by year. When you ask what is the effect of the electric telegraph upon the condition of mankind, I would ask you to think of what is the most conspicuous feature in the politics of our time, the one which occupies the thoughts of every statesman, and which places the whole future of the whole civilised world in a condition of doubt and question. It is the existence of those gigantic armies held in leash by the various Governments of the world, whose tremendous power may be a guarantee for the happiness of mankind and the maintenance of civilisation, but who, on the other hand, hold in their hands powers of destruction which are almost equal to the task of levelling civilisation to the ground. What gives these armies their power? What enables them to exist? By what power is it that one single will can control these vast millions of men and direct their destructive energies at one moment on one point? What is the condition of simultaneous direction and action which alone gives to these vast armies this tremendous power? It is nothing less than the electric telegraph. And it is from that small discovery, worked out by a few distinguished men in their laboratories upon experiments of an apparently trivial character, on matter and instruments not, in the first instance, of a very recondite description—it is on that discovery that the huge belligerent power of modern States, which marks off our epoch of history from all that has gone before, must be held, by anyone who investigates into the causes of things, absolutely to depend. I would venture to hope that this is not all, in its great effect upon the history and government of our race, that electricity may achieve. Whether it so far is good or evil in the main, it must be for the future to determine. We only know that the effect, whatever it is, will be gigantic. But in the latter half of the short life of this young science another aspect of it has been developed—an aspect which I cannot help hoping may be connected with great benefits to the vast community of industrious and labouring men—I mean that facility for the distribution of power of which electricity has given such a splendid instance. The event of the last century was the discovery of the steam-engine. But the steam-engine was such that the forces which it produced could only act in its own immediate neighbourhood, and therefore those who were to utilise its forces and translate them into practical work were compelled to gather round the steam-engine in vast factories, in great manufacturing towns, and in great establishments where men were collected together in unnatural and often unwholesome aggregation. Now, an agent has been discovered by which the forces of the steam-engine, stiff, confined to its own centre, can be carried along, far away from its original sources to distances which are already great, and which science promises to make more considerable still. I do not despair of the result that this distribution of forces may scatter those aggregations of humanity, which I think it is not one of the highest merits of the discovery of the steam-engine to have produced. If it ever does happen that in the house of the artisan you can turn on power as now you can turn on gas, and there is nothing in the essence of the problem, nothing in the facts of the science, as we know them, that should prevent such a consummation from taking place—if ever that distribution of power should be so organised, you will then see men and women able to pursue in their own homes many of the industries which now require the aggregation at the factory. You may, above all, see women and children pursue these industries without that disruption of families which is one of the most unhappy results of the present requirements of industry. And if ever that result should come from the discoveries of Oersted and Faraday, you may say that they have done more than merely to add to the physical forces of mankind. They will have done much to sustain that unity, that integrity of the family upon which rest the moral hopes of our race and the strength of the community to which

we belong. These are some of the thoughts which electricity suggests to one of my trade. Pardon me if I have wandered into what may seem to be speculative and unfamiliar fields. But, after all, the point of view from which we must admire the splendid additions to our knowledge which the scientific men of the world, and especially of England, during this century have made, is that they have enabled mankind to be more happy, to be more contented, and, therefore, to be more moral.

SIR FREDERICK ABEL, C.B., past president, proposed the toast of "The Learned Societies," coupled with the name of Sir George Gabriel Stokes, M.P., president of the Royal Society.

SIR GEORGE STOKES, in responding, said that the Royal Society was the oldest scientific society in the kingdom. For a long time it was the only scientific society, and took under its consideration all branches of science. There were now many societies upon which the Royal Society looked with parental affection; but it so far retained its old constitution that it received papers on all subjects of science. He did not know to which of the categories—the learned societies or the professional societies—they considered themselves as belonging. If they looked at the great achievements in supplying the needs of daily life which had been effected through the agency of electricity, one would say that institution was a professional society. In that very room they had an example of the beautiful electric light which had now become tolerably common, and of which, in all probability, they would see a good deal more in London. Nowadays, the whole earth resembled in a measure one of our own bodies. The electric wires represented the nerves, the messages were conveyed from the most distant regions to the central place of Government, just as in our bodies sensations were conveyed to the sensorium; and then, again, the orders were issued. If those applications were alone considered, it seemed as if that institution was a professional society. But they must look to the manner in which those results had been produced since the first discovery. He could not help going back to the laboratory in Albemarle-street where the great Faraday made so many of his discoveries. He could not help remembering how deeply their president went into the mathematical theory of the electrical actions which take place in submarine cables, and how the success of that first great experiment of spanning the Atlantic was largely indebted to him for his investigations. Therefore he could not look on that society simply as a professional society. He considered that it formed the connecting link between the scientific and the professional.

MR. LATIMER CLARK, past president, proposed the toast of "The Professional Societies," to which SIR JOHN COODE, president of the Institution of Civil Engineers, responded.

THE MARQUIS OF SALISBURY next rose to propose the toast of "The Institution of Electrical Engineers." He said: Sir William Thomson and Gentlemen,—As your toastmaster has told you, the toast of the evening has been committed to my charge, though I fear the lateness of the evening will prevent me from doing it that justice which it deserves. The toast is that of "The Institution of Electrical Engineers." It is now a very interesting moment in the life of the Institution of Electrical Engineers. It is, I understand, your first convivial meeting, and an institution which dines for the first time may be looked upon as a child that has just been weaned. Well, the simile is not so improper, because it has just taken to its bottle. But all I can say in its behalf would be pale compared to the consciousness of its merits which must inhabit the minds of all its authors, and they must feel that I should be profaning a sacred subject if I were to attempt to go into those technical details by which alone its merits could be sufficiently illustrated. But I feel that a paper which has been put into my hands will, at all events, illustrate what great need there was for an institution of this kind, and what splendid possibilities there are for it in the future. I am told that it contains nearly 1,700 members, though it is not a year old, and that it represents the science of electricity, its application to telegraphy, land and submarine, to telephony, to electric lighting, to the transmission of power, locomotion by electric railways, tramways, and omnibuses.

Now, this vigorous infant is obviously the child of the institution represented by Sir John Coode. He may look upon himself when I read this paper as the possible father of a tremendous offspring, for it is evident that this institution will not remain barren. It will increase by what I believe physicists call gemmation, and there will be cut off from it from time to time new institutions representing each one of the copious subjects which I have read. There is evidently, therefore, a great destiny for it in the future; but I think those who have founded it have been wise not to introduce that process of subdivision too soon. It is very well that these various kindred societies should remain together for some time longer, and that that cordiality which distinguishes learned societies should be encouraged in the future by the close association and companionship of their early days. It is indeed a splendid sphere of activity which such a list as this points out for the science of electricity and those who have to give it practical effect. It is a splendid career which it opens to all to whom the maintenance and application of this science is confided. I cannot, whenever I attend, as I occasionally have the privilege of doing, any assemblage of scientific men—I cannot help comparing with a melancholy feeling the endurance and permanence and almost eternal existence of their work with the transitory effect of the work of the profession to which I belong. Politicians may do good or they may do harm. They hardly know what result destiny will give to their actions. They do not know how the Divinity will shape the ends which they are trying to rough-hew. They cannot so measure the causes which act on the formation of human events and human history as to judge of the permanence or the transience of their work. With you it is otherwise; every brick which you add to this great pile will last as long as human consciousness endures; every atom which an electrician brings to the great science which he cultivates will remain there doing its work right to the end, as long as the intellect of man exists by which the science can be applied. It is, therefore, a great destiny which your institution has before it, and a great responsibility which lies before you. In asking you to drink to the good fortune and good health of this institution I will ask you also to couple with it the name of one who, more than any other living man, has given to electricity its power and his fame. In asking you to drink to it in conjunction with the name of Sir William Thomson I add the name of one whose marvellous investigations, whose extraordinary inventions, and the singular accuracy and practical character of whose science, have been felt by everyone present in the practical carrying out of his work. If Faraday or Wheatstone have begun this work, the historian will record that no stronger hand ever existed to carry on the sacred flame to future generations than the hand of the distinguished and gifted man who has been your president this evening. I give you "The Institution of Electrical Engineers," joined with the name of Sir William Thomson.

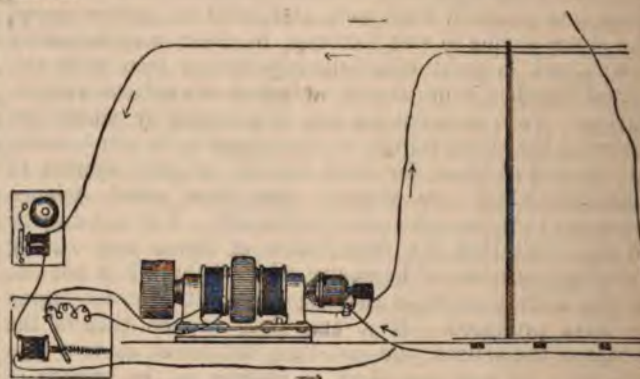
Sir WILLIAM THOMSON, in responding, said that in proposing the health of "The Queen," he felt that the reign of Queen Victoria and the history of electricity as a branch of applied science were synchronous to a most unique degree. The science of electricity was as old as human learning. In the remotest times Greek and Arabian philosophers had something of our present electrical knowledge. Last century was full of work of pure electrical knowledge, but what was most remarkable was the tremendous development it had received since 1819. In 1837 the electric telegraph came into existence, and although he did not say it was invented by Cooke and Wheatstone, it became a practical servant for man through their labours. One very remarkable piece of work they should think of especially this year, and during the last few weeks, when they deplored the loss of one of the greatest workers in electrical science and its practical application that the world had ever seen—Joule. The great scientific discoveries of Faraday, which were prepared almost deliberately for the purpose of allowing others to turn them to account for the good of man, had been going on for about 15 years, when a young man took up the subject with a profound and penetrating genius most rare in any branch of human study, and perceived relations with mechanical power

which had never been suspected before. Joule saw the relations between electricity and force, and his very first determination of the mechanical equivalent was an electrical measurement. His communication to the British Association when it met in Cork in the year 1841 pointed out for the first time the distinct mechanical relation between electric phenomena and mechanical force. Joule was not a mere visionary who saw and admired something in the air, but he pursued what he saw to the very utmost practical point of work, and he it was who determined the mechanical equivalent of heat. Afterwards he thoroughly confirmed the principle of his first determination of the mechanical equivalent of heat. Both in electricity and mechanical action he laid the foundation of the great development of thermo-dynamics, which would be looked upon in future generations as the crowning scientific work of the present century. It was not all due to Joule, but he had achieved one of the very greatest monuments of scientific work in the present century. For an Institution of Electrical Engineers it was interesting to think that the error relating to one of the most important electrical elements, the unit of resistance (now called the ohm), as determined electrically in the first place by a committee of the British Association, and by purely electrical method, was first discovered by Joule's mechanical measurement. It was Joule's mechanical measurement which first corrected the British Association unit and gave the true ohm. The Institution of Electrical Engineers had not come into existence exactly like Minerva; it began with the Institution of Telegraph Engineers in 1870, and it had during the subsequent 19 years been growing up, until it had at last become the great Institution of Electrical Engineers which it now appeared to be. He thanked them most warmly for the great honour they had done him in choosing him as their first president, and for the way in which they had received his name in connection with the toast which Lord Salisbury had just put before them.

The company then separated.

SAFETY GUARD WIRE FOR OVERHEAD ELECTRIC RAILWAYS.

The accompanying cut illustrates one of the recent devices of the Short Electric Company, the object of which is to remove all danger of injury from shock in case a wire of any description should fall across the electric conductor.



As will be seen in the cut, there is a wire suspended above the conductor and parallel to it. This can be an ordinary iron telegraph wire, and is about four inches higher than the conductor. It passes into the station through a call bell, and a regulating device is attached to the generator, and thence to the ground. In practice, should any wire fall across the line, touching only the guard wire, notice is immediately given in the station by the ringing of the bell, but should it also touch the conductor, the regulator is operated, and the E.M.F. at once reduced to 100 volts, at which there is no danger from handling the wire, while enough force remains to propel the cars slowly along until one of them reaches the obstruction. The fallen wire may then be handled with impunity, and, on being removed, the gene-

rator at once builds up automatically to its regular power, and the usual running of the road is resumed.

A SIMPLE METHOD OF TESTING WIRE INSULATIONS.

BY H. B. BROOKS.

There are so many different insulated wires now made that it often becomes difficult to select from them. The ordinary method of comparing the value of insulations by determining the insulation resistance in megohms is, no doubt, the most scientific way, but it requires expensive apparatus and a degree of skill which is not usually found in the average central station staff.

The writer has for some time made use of a method which requires hardly any apparatus, provided access may be had to an E.M.F. of from 100 to 200 volts.

Samples of the wires to be tested are measured off in equal lengths, say, 5ft. each. Commencing at a point about 6in. from one end, a bare copper wire, about No. 18 or 20 B. and S., is wound on over the insulation in an open spiral, ending at a point about 6in. from the other end, as shown in Fig. 1. At this point a knot is tied in the bare wire to prevent its sliding or uncoiling, and about a foot of it is left for a connection. About half an inch of the insulation is removed from one end of the test wire.

FIG. 1.

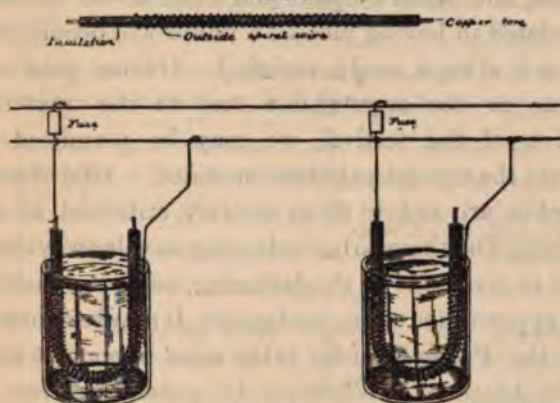


FIG. 2.

Each wire having been thus prepared is doubled up several times so that it may be placed in a glass jar, with the portions at each end not covered by the spiraled wire situated above the water line, as shown in Fig. 2. Several wires may be placed in one jar, but it is more convenient to place each wire in a separate jar. Water is then poured into the jars, and the ends of the outside spiral wires are connected direct to the — pole of the dynamo, and each copper core inside of the insulation is connected through a piece of fine fuse wire to the + pole, as shown.

The time of turning on current is then noted, and also the time when each wire "leaks" enough to burn off its safety fuse.

This is a simple and practical way of comparing insulations by exposing them to the same kind of strain they receive in practice, but more severe.

In a recent test made by the writer, "undertaker's" wire lasted about 40 hours; a cheap line wire nearly the same time; a good line wire 275 hours, and a still higher grade of wire 895 hours. In the case of highly-insulated wires, the E.M.F. should, if possible, be increased in order to shorten the duration of the test.—*Electrical World*.

THE ELECTRIC DETECTOR SIGNAL.

We have received from Mr. Peddie a description of this system, which he contends is required for railway work. His object is to utilise the electric light for railway signalling, etc., and to render the ordinary sight signals thoroughly reliable and effective in all kinds of weather, and irrespective of any carelessness or misunderstanding on the part of the engine-driver, by giving an unmistakeable

combined electric sight and sound signal simultaneously on the locomotive and in the signal-cabin should the train "run the signals," and thus greatly increase the safety of railway travelling. The apparatus is specially designed to work along with the ordinary system of sight signalling, so that in the event of a train not fitted with the apparatus coming on the line, it will still have the ordinary signals to fall back upon.

From the poles of an electric battery, or other source of electrical supply in the signal-cabin, a pair of leads run to an electric lamp on the semaphore. One of these leads is also led from the semaphore to another conductor, which runs between the rails from opposite the signal-cabin to opposite the semaphore. From one of the rails which serves as the return circuit, a conductor with an electromagnet in circuit is led to the other pole of the battery. This electromagnet is placed close to a switch which, when operated, will light an electric danger-coloured lamp and ring an electric bell in the cabin. When the line is clear the contact with the conductor between the rails is broken, but when the line is to be blocked the signalman will set the signal at danger in the ordinary manner. This will throw the danger-coloured glass in the spectacle frame of the semaphore opposite the electric lamp in the ordinary manner, and at the same time will switch the conductor between the rails into contact with the lead from the semaphore.

From the floor of the locomotive (and, if desired, from the floor of the guard's van and any carriage of the train) a pendant wheel is placed so as to travel over the conductor between the rails. From this wheel a conductor runs to an electric danger-coloured lamp, and thence to an electromagnet placed near a switch, which operates an electric bell, all of which are on the weather-board of the locomotive (and, if desired, in any carriage of the train), and thence to the axle. Should the train "run the signal" when the latter is at danger, the conductor between the rails being in contact with the battery, whenever the pendant wheel passes on to it the circuit will be complete, the current will pass up the wheel and light the electric danger lamp on the locomotive, etc., and magnetise the electromagnet, which will switch and ring the electric bell. It will then pass by the axle, wheel, and rail, to the electromagnet in the signal-cabin, magnetise it, and thus switch and light the danger lamp and ring the electric bell and return to the battery. Thus it will be impossible for the engine-driver in any circumstances to misunderstand the signal when it is at danger, and the signalman will be timely warned of the engine-driver's error if the latter disregard the signals. If the guard's van and carriages are also fitted with lamps and bell, of course the guard and passengers will also be notified of the engine driver's fault.

The electric lamp on the semaphore may be switched off during the day time, and may be dispensed with altogether, and the ordinary oil lamp used instead if preferred. In this case one lead runs from the battery to the conductor between the rails, and another lead from one of the rails to the other pole of the battery, the current being only used for the lamps and bells on the train and in the signal-cabin. Instead of only one electric lamp, with the spectacle frame on the semaphore, the latter may be dispensed with and two lamps used, one being a danger-coloured lamp. When the signal is at "line clear" the ordinary lamp is lit, but when it is set to "line blocked" it switches out the ordinary lamp and switches in the danger lamp, at the same time switching the conductor on the line into contact with one of the leads from the battery. The electric bell on the locomotive may be dispensed with, and the magnet used to open the valve of a small cylinder, which will pass steam and sound the whistle. When the current is stopped, the danger lamp will be extinguished, a spring will draw up the valve and stop the whistle, thus indicating that the train can proceed. The apparatus slightly modified can be used for coal pits and mines, and will indicate both in the engine-house and in the pit when the train of hatches reaches the top or bottom.

The adoption of this system would involve enormous expense, and we should imagine the railway authorities would be almost frightened at it, even if they admitted the efficiency and certainty of the apparatus.

THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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IMPORTANT NOTICE.

We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No paper that we know ever refuses Subscribers or Advertisers. Nor do we; in fact, we invite them, believing that they will get full value for their money.

Specimen copies of the paper will be sent on request.

THE INSTITUTION DINNER.

It was a happy thought to inaugurate an annual festival in connection with the Institution, and it has been admirably carried out. Those who attend such meetings are apt to forget the great labour undergone by someone to organise and arrange so that the greatest possible comfort is obtained with the least possible friction at the festive board. But, further, the labour attaching itself to a first meeting is greater than for any other. Once pointed out the right direction, and many can follow. It is the initiation that is difficult. The way of the world is to kick those who take the first step, and pander to those who follow. Electrical engineers are a little careless of what the world thinks, and apt to take their own line—hence they will certainly join us in awarding a due meed of praise to those who organised the festival, and especially to Mr. Webb, whose persistent work from start to finish has conducted much to the success obtained. The selection of the place of meeting was justified by the results, and Messrs. Spiers and Pond are to be congratulated in having pleased a number of people who are not always easily satisfied. Having paid our tribute to the organisation and to the material portion of the festival, we may be permitted to discuss the mental pabulum provided. After-dinner speeches are not to be so severely criticised as set orations. They have to be made, some to wile away time, some to give *éclat* to the gathering, and some to show kind appreciation of time and people. It may be assumed that the Prime Minister is the most important man in the kingdom. Wherever he goes, whatever he does or says is watched, not by the few individuals gathered within the four walls of a dining-room, but by the whole of the civilised world. Even Prime Ministers have their hobbies, and in his leisure moments Lord Salisbury dons the garments of the scientific man. He changes his occupation from the weighty affairs of the State to the experiments in his laboratory. According to common report, Lord Salisbury is no mean chemist—his speech at the Institution dinner shows his appreciation and extensive knowledge of the developments of electrical science. Like all investigators worthy of their salt, he not only studies the past and the present, but dreams of the future. Now dreams are only the shadows that haunt our brains. They may or they may not receive the allegiance of our waking thoughts, yet who so happy as the scientific man, mentally looking far away into dim futurity, and speculating upon the applications of one of his favourite sciences, and the benefit which will accrue therefrom to humanity? Lord Salisbury indulged in one of these day-dreams—or at least we imagine he must have done so—when describing in somewhat glowing terms the advantages that might come to the home life of the worker could he get

the power required for due pursuit of his labours brought into his own house—brought in the guise of electric energy, without noisome smoke and rattle, to the machine, which the mere turning of a switch would start into life and action. The vision of the peaceful home, the workers pursuing their various avocations without any necessity for breaking the family circle, is a phantasm which is not likely to be realised, and which if realised would be disastrous instead of beneficial in its effects. It is but a few weeks ago since the country was thrilled with descriptions of the life and labours of the nailworkers, and later still with tales of sweaters and sweated in the East-end of London. What will the distribution of electrical energy do for these classes of workers, and these are the classes working in their own homes? The lowest depths of degradation and misery seem reached in the hovels of the nailers, and the slums where tailors, tailoresses, and seamstresses do congregate. The aggregation of labour in factories around the steam-engine has led to legal restrictions which impose sanitary and other regulations, easily inspected and tending to the welfare of the worker. Then the best system of distribution of labour can be adopted in factory work, and could not be in work done at home. It is needless to do more than indicate some of the reasons that militate against universal home work, and to show that the dream is one impossible of realisation. No, let the labourer have his home or something apart from his work, a place of rest and recreation, where nothing tells of the pains and penalties whereby he earns his daily bread. The application of science, even electrical science, like all good things, becomes bad past a certain limit, and to get the full benefit, the limits imposed by natural conditions must not be passed. There is one aspect of this dream which indicates the waking mind of the man as much as words can possibly do, and points to the intense interest of the speaker in the welfare of the working classes. The Poet Laureate has well depicted the views of the educated and thoughtful man of this latter part of the nineteenth century when he says:

Yet I doubt not through the ages one increasing purpose runs,
And the thoughts of men are widened with the process of the
suns.

It must not be understood that we are averse to the distribution of electrical energy. We have always been the strongest advocates for progress in this direction, but we differ as to the limits of such distribution.

With this exception, perhaps, all his hearers and readers can agree with Lord Salisbury. Telegraphy has altered the conditions under which we live and work. Politicians now know what happens at the remotest centres of interest almost as soon as the action occurs. They are in touch with the to-day,

not with time six months old. The speeches of Australian politicians, for example, are discussed here almost as soon as in the town in which they are uttered. But the value of the telegraph is not in its use to politicians so much as to business men. The agent in Singapore can telegraph and get his goods in one half the time and less, than before the era of cables. With the same capital our markets can be more than doubled, and this is too little understood by statisticians who revel in figures illustrative of the world's progress. In many, if not the majority of cases, the increased bulk of trade is directly due to telegraphic connections.

NEW YORK NOTES.

(FROM OUR SPECIAL CORRESPONDENT.)

The Electric Lighting Situation in New York.

Absence of Light Keeps the Police Busy.

Common-Sense Returning.

The Companies Renew their Wires and Start up Again.

More about the Little Ways of the Board of Electrical Control.

A Scandalous Record.

The Feeks Inquest.—Consulting Electricians.

The Fire Marshal and the Switchboard.

Electrical Meetings.

Train Lighting, Electric Traction, Electrical Exhibitions, and More Transatlantic Notes.

NEW YORK, October 25, 1889.

The agitation against the electric light companies has calmed down somewhat during the present week, and the writers for the daily press, being fully occupied with the contest for the base-ball championship and the Cronin murder trial, have, to the great relief of scientific men, refrained from continuing the highly-coloured effusions on electrical matters with which the newspapers fairly reeked all last week. The Brush and United States Companies have not yet resumed the lighting of their street circuits, and will probably not do so until a decision is arrived at by the judge of the Supreme Court on the arguments for and against the upholding of the injunctions granted to the companies forbidding the Board of Electrical Control to carry into effect its intention of forcibly removing the overhead wires. The judge's decision will probably not be announced until early next week, but it is believed that it will be in favour of the companies, as it appears that the Board have no power to take down overhead wires except in those districts where subways are in readiness for the wires to be put underground.

The absence of the electric light in the streets during the past fortnight has rendered New York not only a very dismal, but also a very dangerous place to be about in after dark. The gas companies have responded but feebly to the sudden call made on their resources, and in many cases it was impossible for them to do otherwise, as so firmly was the electric light established that in numerous streets not only had the gas been cut off, but the lamps had been removed, and the gas companies possessed no stock from which to replace them. Consequently, in some localities darkness has reigned supreme and crime been rampant. Numerous cases of sandbagging (a form of garrotting peculiar, I believe, to New York, the *modus operandi* being to strike the victim one or more blows on the head with a long bag filled with sand, and having the extremity fortified with a lump of lead; the blow leaves no external mark, but effects considerable internal disturbances, generally resulting in death) have been reported, to say nothing of minor crimes and burglaries, while the police have added to the general confusion by a little wild revolver practice which has resulted in the death of one man, and in the dangerous wounding of another, who received two bullets from a policeman who was chasing a supposed criminal along the streets in the dark. The public are beginning to see that the absence of the "deadly current" is likely to result in more destruction of life and property than the

continuance of its use, and the reaction having set in it is more than probable that electric lighting affairs will soon be again in a normal state and go on pretty much as before.

In one way the companies have profited by the recent excitement, as by shutting down all their circuits they have been able to thoroughly overhaul their tattered and worn-out "undertaker's" wires and replace them with new wires of improved manufacture. Gangs of men have been busy for the past week in all the principal streets taking down old wires and putting up new, and the demand for good insulated electric light wire has, for the moment, far exceeded the supply. The manager of a prominent wire-covering company told me the other day that if he had had 100,000dols. worth of electric light wire in stock he could have sold it all last week. The deduction is that the overhead wires in New York must have been in a pretty bad state. To-day the counsel for the Brush and United States Companies have notified the authorities that from to-night they will start up again all circuits supplying current to private customers, those circuits having been entirely rewired with well-insulated conductors. They are forced to do this, they say, as the Mount Morris and East River Companies, which have not shut down, are robbing them of their customers, and those customers who have held by them are suffering much inconvenience from the absence of light. The Board of Electrical Control has taken no further action, and now seems to be pursuing a policy of holding aloof, as the expert of the Board has declined to certify to the insulation of the new wires put up by the companies, alleging that he is too busy locating bad wires which are to be taken down.

In a previous letter I alluded to the scandalous attitude of the Board on the subway question, with regard to the decided manner in which the three commissioners upheld the monopoly of the Subway Construction Company. Heartly condemnation of the actions of the Board is manifest in the comments both of the technical and general press, and an opinion seems to be spreading that the Board ought to be "wiped out," or, at any rate, reconstructed and composed of men capable of dealing both with the scientific and practical sides of the questions upon which the present Board is supposed to decide—but never does. Last Sunday the *Herald* devoted three columns to a publication of the inside history of the Board since its formation, and a more scandalous manipulation of misplaced authority to foster private interests could scarcely be met with in all the annals of conscienceless jobbery. The article is too long even to quote from, but it appears that the Board, which was originally styled the Subway Board and only lately blossomed out as the Board of Electrical Control, was founded in the interests of the Subway Company, and the three commissioners have been the instruments of the Subway Company from that day to this, which is pretty well borne out by recent actions of the commissioners. That the commissioners do not know the first thing about electricity or the proper construction of subways has always been self-evident, and cannot be wondered at when it is considered that the original calling of the gentlemen in question are, according to the *Herald*, those of a "butcher, ticket-seller, and law clerk!"

The inquest on the causes which led to the death of the lineman Feeks has occupied several days' sittings, but no satisfactory conclusion as to which wire originally carried the fatal current has been arrived at. The wires on which Feeks was suspended belonged to the Metropolitan Telephone Company, and several annunciator drops were burned out at one of the exchanges; a cheerful undertaker's assistant created a diversion at the inquest by describing in glowing terms the beautiful firework display afforded by the telephone in his establishment at about the time of the accident. Among the witnesses examined were employes of the various electric light companies, and one and all testified that no disturbance was noted at the dynamos on the day of the accident, and that none of their wires were out of order or in contact with other lines. The linemen of the Western Union and Metropolitan Telephone Companies, who were sent out to trace the wires in each direction from the pole on which Feeks was killed, testified that they failed to find any point of contact between the telegraph and telephone wires and those of the electric light

and power circuits. In some quarters the opinion is expressed that Feeks was killed by a shock from one of the "ticker" wires of the Western Union, which carry an alternating current of about 320 volts pressure.

In writing of the Feeks inquest last week I mentioned that Mr. Charles Cuttriss, the electrician of the Commercial Cable Company, would appear as a witness. This was a partial error, as Mr. Cuttriss, instead of being subpoenaed, had a less unpleasant and more profitable connection with the inquest, he being retained by the coroner as expert to advise that official on the technical points connected with the enquiry. Mr. Cuttriss has just lately opened an office as consulting electrician, and his long experience should render his services specially valuable to those requiring expert advice, and here, where practice is generally more thought of than theory, they are many. The consulting branch of the electrical profession is comparatively neglected in New York, and of the few who have set up as consulting electricians several make the obvious mistake of also announcing themselves as contractors. If a man goes in for contracting he is morally bound to favour certain systems, and when called upon to give his opinion in his consulting capacity that opinion can scarcely be altogether unbiassed.

An amusing instance of the effects of the late scare in the way of attributing all sorts of disaster to electricity, which was crowded out of my last letter, occurred in connection with the recent fire at Dr. Talmage's tabernacle in Brooklyn. It is believed that the fire was started by the building being struck by lightning, as there was a heavy thunderstorm that night. The fire marshal, however, stoutly declared that the fire must have originated with the switchboard of the Edison installation, which had just been completed in the tabernacle. The Edison Company declared that no current was turned on during the night of the fire, but the marshal insisted that his opinion was correct. Now, however, he is probably convinced that even a fire marshal may occasionally be wrong, as when the ruins were searched the switchboard was found intact, and in such good condition that the clock in the meter was still ticking!

Within the last week or so there have been quite a number of electrical meetings. Last week I recorded those of the American Institute of Electrical Engineers and the New York Electric Club. The same week the Association of Railway Telegraph Superintendents held a largely-attended meeting at Washington. The principal subject brought before the meeting was that of "Train Electric Lighting," which was discussed in a long paper by Mr. Charles Selden, superintendent of telegraphs of the Baltimore and Ohio Railroad. Mr. Selden divides the lighting of trains by electricity into three systems: 1. By the joint use of dynamo and storage battery. 2. By means of direct current from the dynamo. 3. By means of a charged storage battery. System No. 1 is deemed to be the best, and has been adopted by the Pullman Company with excellent results.

The American Street Railway Association held their eighth annual meeting at Minneapolis last week, and devoted all their time to discussing the subject of electric railways. Favourable reports were received from all street railways operating by electricity, both as regards economy and efficiency. The report of the committee which had been investigating the electrical traction question concludes as follows: "In closing, we would say it has been stated that electricity as a motive power is as far ahead of the cable as the cable was an advance over horses."

At the 122nd meeting of the New York Electrical Society, held last Tuesday, Mr. A. A. Knudson read a paper on "Electrical Exhibitions, What to Show and How to Show It, with Suggestions for the World's Fair of 1892." Mr. Knudson's paper scarcely bore out the promises conveyed by this somewhat grandiloquent title, as it contained little beyond a description of the recent exhibition at St. John's, N.B., and of the method employed in firing the guns from Vancouver and Montreal at the inauguration of the exhibition. "What to Show and How to Show It" were conspicuously absent, unless the inference was intended that all that could be learnt by studying the scheme and results of the exhibition at St. John's.

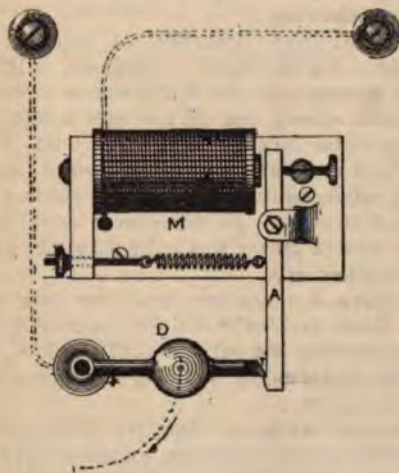
The only suggestion for 1892 was that Niagara should be reproduced on a natural scale, right here in New York, the falls to be illuminated by electricity! Rather a large order even for the Empire City. Mr. Joseph Wetzler, one of the editors of the *Electrical World*, gave a very interesting discourse, in which he embodied various electrical notes picked up during his recent visit to the Paris Exhibition and trip through England. Mr. Wetzler described various novel pieces of apparatus which he saw in Paris, among them being a steno-telegraph instrument capable of transmitting 260 words a minute. This the meeting resolutely declined to swallow. Much interest was evinced in Mr. Wetzler's description of the Deptford station, where he was shown round by Mr. Ferranti. Like Mr. Lockwood, Mr. Wetzler laid stress on the superior style of overhead construction noticeable in England and the total absence of poles from the streets of cities. Mr. Martin, during the discussion, suggested that a not unlikely cause for this was that the streets were too narrow for the poles! This completely upset the gravity of the meeting. While Mr. Martin was speaking a fire-engine passed in the street below with bell clanging loudly, and for a moment his remarks were interrupted. "Humph," he resumed, "probably a fire caused by gas," and the meeting again relapsed into audible merriment.

TELEPHONE PROTECTOR.

Accidents to the telephone and telegraph apparatus from the contact of outside wires with electric light or electric railway wires are of frequent occurrence.

Through the careless handling of a wire by an ignorant lineman a number of valuable instruments may be destroyed or seriously damaged.

To prevent this mischievous action of heavy currents Foree Bain, of Chicago, has designed the little device here-with illustrated. It consists of a one-pole electromagnet,



M, so wound as to be energised by a current of a volume that would be liable to injure the apparatus: an armature, A, and a drop lever, D, with platinum contact at T. The magnet, armature, and drop lever, when set, as in the cut, are connected electrically in a series whose terminals are the two binding posts.

This device is cut into the main line before it reaches the instruments. Its action is quite simple. Suppose a heavy current passes through the line. The armature, A, is instantly attracted, and the drop lever, D, falls, thus breaking the circuit.—*Western Electrician*.

CONDITIONS NECESSARY TO THE SUCCESS OF ELECTRIC RAILWAYS.

BY T. C. BARR.

We have recently had enquiries as to the cost and maintenance of electric railroads, and have been unable to do more than refer our correspondents to American sources. The fact is that we on this side of the Atlantic are woefully behind with electric traction. Thus, again, for figures

we have to go to the Americans to find that at the annual meeting of the American Street Railway Association, at Minneapolis, a report was read and discussed under the above title. The following is the report and discussion as given by our contemporary the *Western Electrician*:

The subject of "Electricity as a Motive Power" has been the all absorbing topic before our meetings for the past two years, and only now are we able to give any satisfactory answer. Up to the date of our last meeting in Washington, October 17, 1888, we had made very little progress in the application of electricity to the propulsion of cars, although a solution of the problem was deemed not far distant. At that time the number of roads equipped and operated by electricity could be counted upon the fingers of your two hands, while to-day they number in the hundreds, a surprising result, all within the short space of twelve months.

This result could only have been brought about by the fact that the experiments heretofore made had proved a success, far beyond even the expectations of those making them, and we have established to-day, without a doubt, the success of electricity as a motive power. Having ascertained this point, we are next led to the question, What are the conditions necessary to the financial success of electricity as a motive power?

In the application of electricity we are not met with the volume of business, or the engineering and mechanical construction, as brought to our attention from the report upon the conditions necessary to the financial success of the cable road, but can simply say that if it is desired to make a change from horse power, electricity will fill the bill to perfection, no matter how long or short the road, or how many passengers are carried. In the investigation of the subject the most satisfactory results have been shown; it not only increases traffic over the road, but reduces expenses, and will enable us to operate a line, which heretofore entailed a loss, at a profit. We have three methods of operation, as follows: The overhead wire, the conduit, and the storage battery, which will accommodate all conditions.

For the overhead wire, we can only say that it is all that can be desired, and for suburban roads and small towns, and even in cities, at present cannot be equalled. The conduit has found very little favour in the eyes of practical men by reason of the unsatisfactory results heretofore attained by those who have experimented with it, while the storage battery is gradually but surely pushing its way to the front as the most perfect system, and is now only awaiting the development of a battery which will stand the hard knocks and usage which it must necessarily get in the operation of a street car, without destroying its component parts. The overhead method having been demonstrated to be the cheapest of the three methods, is being universally adopted, and with results that cannot but help to keep it in the front ranks, as a cheap power to propel cars. We have yet to learn of any person who has seen the operation of a road by this system, and has ridden in the cars, who has not declared it without reservation to be just what was wanted. In the large cities we are met with the objection to overhead wires, which necessarily compels us to favour the storage battery, and yet if the consent of councils could be obtained there is no doubt that the overhead construction would be placed in operation at once.

If a change is desired in the manner of operating a road, we are not compelled to figure an elaborate cost of construction, which, if of cable, would cost something like 70,000 to 75,000dols. per mile, in addition to the cost of a power plant, but are only confronted by the small amount of, say, from 2,000 to 3,000dols. per mile, with cars costing from 3,000 to 5,000dols. apiece, while, for the storage battery, we have a figure still less, by reason of the wire being dispensed with, so that a comparative statement of the cost of construction of a 10-mile road complete, with 15 cars, would stand probably as follows:

Cost of cable construction	\$700,000
„ power plant.....	125,000
„ cars	15,000
	\$840,000

Electrical overhead wire construction :

Cost of road-bed	\$70,000
" wiring.....	30,000
" cars.....	60,000
" power plant	30,000
	\$190,000

Storage battery :

Cost of road-bed.....	\$70,000
" cars.....	75,000
" power plant	30,000
	\$172,000

In the above cases of electrical construction the motor car would be capable of pulling one or two tow cars if necessary. These figures, your committee has no doubt, will be found to be calculated within a reasonable limit of cost. Now, to get the most economical service and the best results it would be well, in the judgment of your committee, to rebuild your road bed (if an old road) and start with a construction that would be as near perfect as possible, and that to be a girder rail construction, with ties 2ft. 6in. apart, 5in. by 7in. yellow pine, your rail to weigh from 45 to 60 pounds, the weight to depend upon the traffic that would in all probability be carried upon it. This is no doubt the most important step after deciding to adopt electricity; by this means you reduce the amount of wear and tear on your cars to a minimum, and prevent to a certain extent the damage to your motors, or if a storage battery, the constant jarring of your batteries. It will also enable you to maintain a more even rate of speed, as also a much faster rate than could be obtained under any other conditions. It is advisable, also, to have your motors examined after each trip, and see that nothing is out of repair. Do not let the motors work at a disadvantage, as a dollar or two expended at the proper time will save you hundreds in the future. Also see that the men running your cars are careful and capable of exercising a little judgment. A careless man will ruin your motor in a short time by forcing the whole current through it, when there is no reasonable excuse for the same; particularly in starting the cars, a little attention in this direction will amply repay you for the time and expense devoted to such inspection.

If you are running a number of cars it will probably be more economical to put in your own power plant rather than depend on an electric light plant, or it may be absolutely necessary to put it in by reason of having no such source of power. This plant need not necessarily be placed along the line of your road, as the power being transmitted through a wire the plant can be placed where the cost of running the generators will be the least, which, if water power is at hand, or if in a coal district, would tend to materially reduce the cost; yet for ordinary purposes power can be leased from any electric light plant at a reasonable cost per car per day.

As to your cars, the majority are now ordinary 16ft. bodies placed upon independent trucks, so that old cars can be utilised, but if a new equipment is desired it would be best that the bodies be placed upon independent trucks, and that both ends be closed, or, in other words, a bow window front and back, with the side entrance clear, as in the ordinary car. Or if your road is a double track with loops, and your cars run in but one direction, it would be still better to have the front entirely closed, as in the construction of the latest style of cable cars. This construction of the car will protect that portion of the electrical apparatus which is now exposed to the elements, and still make a much neater car, or if your road carries a large number of passengers a 20ft. to 22ft. car upon double trucks, the same pattern would give even better results. With the small cars have at least two motors of 15 h.p. each, and with the large ones it is a question whether or not the motors should be 20 h.p. each. Do not stint the power of your motors. There is no doubt in the mind of your committee that considerable of the trouble heretofore experienced has been for the want of sufficient motor power. With this power under your cars and the wire overhead, you may safely climb grades of 10 per cent. and more with perfect ease,

but with the storage battery it is hardly safe to climb a grade of more than 6 per cent.

The question of operating your line during the winter months is also a serious one, but there is no doubt that if the rail is kept clear, little or no trouble will be experienced. To do this it is desirable, in addition to a plough, to use a large sweeper, operated by two 15 h.p. motors, with the brooms working independent of your gear, and propelled by a separate 15 h.p. motor; using at your curves and switches some little salt to keep them clear. This will keep your rail as clear as required under ordinary conditions, and in addition to the above you should have attached to the cars a small scraper in front of the wheels, to keep the accumulation of snow or ice from the track that may be thrown there by the traffic on the street.

Now to the cost of operating your road. This will rest solely with yourself. It should not, under any circumstances, exceed 10 cents per mile, to include the cost of your conductors and drivers. Of course there are exceptional cases where the cost is much greater by reasons of conditions which do not exist ordinarily. It was the desire of your committee to be able to furnish you with some exact figures on this particular point, but it was found almost impracticable, as the majority of those from whom the information was sought preferred not to disclose the cost of running their roads. A few figures, showing the gross earnings, as well as the operating expenses for some of the months of the past year on roads operated by electricity, will probably be interesting, although the names of the roads will be withheld.

Operations of a road for the month of August, 1889: Gross earnings from operation, 3,821.95dols.; total operating expenses, 1,856.67dols.; showing net earnings to be 1,965.28dols.; and in the operating expenses of this month were included 480dols. interest charges on floating and bonded debt. Total mileage for the month, 19,181 miles; average cars operated, eight; average cost per mile per day for operating road, 9.67 cents; deducting amount of interest charges, will give 7.12 cents per mile, which is certainly a very satisfactory showing.

For the first 31 days' operation of another road, we have: Receipts, 8,796.40dols.; expenses, 2,164.00dols., showing net earnings to be 6,632.40dols.; with motors making 19,930.5 miles; and of tow cars making 11,610.1 miles; average motor cars operated daily, 5.93. This shows a cost per mile of motors of only 10.86 cents, and adding the additional mileage of tow cars reduces the cost per mile to a figure of 6.86 cents. In this case it would be well to note that the cost of power was reduced to the average of 1.39dols. per car per day.

Again, we have for another road for the month of July, 1889: Receipts, 10,695.00dols.; operating expenses, 3,735.00dols., showing net gain of 6,870.00dols., with the motors making 46,647 miles, showing average expense per mile 8.01cents.

For another road we have: Receipts from operating 80 days 5,500.80dols., total operating expenses 3,441.27dols., showing net earnings for that period of 3,059.53dols.

Another road, for 75 days: Receipts 6,132.15dols., total operating expenses 2,843.54dols., showing net gain for that period 3,338.61dols. This road, running 17,063 miles, giving the average expense per mile of 16.66 cents.

Last, but not least, we have a report of a road for the month of August, 1889: Operating receipts, 4,317.46dols.; total expenses, 871.04dols.; net profit, 3,446.42dols. The total expense of this road figures at 14 cents per mile.

The average number of miles that an electric car should make under favourable circumstances is at least 120 miles per day of 18 hours, which is 50 per cent. in excess of what we can now get from horses.

It will, perhaps, interest some of you to listen to a few extracts from a letter written by one operating an electrical road, in which he says: "We find a flattering comparison in favour of the electric motor, and have experienced great difficulty in keeping the people off the roofs of the cars, so anxious are they to ride; have carried them on the brake beams; hanging out of the windows and on coupling bars. A single car whose seating capacity is 22, has carried 102 passengers in one load. We have experienced no difficulty whatever in carrying

these loads up the steep grades of our city. We can further state that in our six miles of track we have but one block without a grade of from 1 to 11 per cent. So great has been the increase of travel since we began to use the motors in place of horse-cars, that we have already found it necessary to quadruple our equipment." The instances stated above are only a few of the many from roads operated by electricity, all of them showing an increase in traffic, and paying large dividends to the holders of the stock. The most notable instance of the past year has been the resolution of the board of directors of the consolidated roads of Boston to equip their whole system with the overhead wire. A portion of this system has already been equipped, and, from the statement of President Whitney, we have the fact that on their extension to Arlington of the Cambridge division, there has been at least 150 per cent. increase in traffic, with 50 per cent. decrease in the operating expenses, giving us a net gain of 200 per cent., which is something marvellous. We have had, unfortunately, within the past months a report of the breaking down of the overhead system in the city of Richmond, and yet with all the results from reports as to the success of the overhead system we will have some few who will bring this road up as an example of what the future will be of roads operated by the overhead wire. Why this should have occurred in Richmond is hard to tell, and can best be explained by someone with a knowledge of the cause. The question of the relative merits of the different systems of electrical construction it has been thought best to leave open to discussion by the members of the association.

In closing, I would say it has been stated that electricity as a motive power is as far ahead of the cable as the cable was an advance over horses.

DISCUSSION.

Mr. John S. Wise: I represent as counsel the Sprague Electric Company, which has been slandered so much in connection with the electric railway at Richmond. I desire to make a statement here as to the condition of that road and the causes of its failure, which I think will be satisfactory to any impartial mind. The Richmond Union Passenger Railway Company was chartered by the State of Virginia and the city of Richmond, through the influence of Maurice B. Flynn, of New York, who, with his companions, obtained that charter, and made a contract with the Sprague Company for the equipment of the road. In the first place, it was a scheme to put in a shoe-string and pull out a tanyard. It was not backed by the proper capital at its beginning. It was a very desirable charter; it was a very desirable enterprise for an electric railway equipment company. The Sprague Company, in its anxiety to obtain the largest and longest electrical railway in the world, concluded a contract with Mr. Flynn. The track was laid, I believe, with secondhand rails; at any rate, many of them 30lb. to the yard, of the lightest and most inferior kind, and to-day the rails all along that road are slivered off, as if they had been hammered. There is not a plumb rail on the road. The curves were 24ft. curves, and they were not bound in any way. The road was not ballasted from one end to the other; that was the character of the work which the owners of the road had put down, and to-day it will take 13,000dols. to put the track in any condition at all, and with that the electric company had nothing to do. The cars have been there only two years, yet they are in a horrible condition; they are dirty and neglected, they look as if they were twenty years old. For many months they had employed blacksmiths to repair the motors, and had used brushes which were of such inferior material that they would be destroyed in a single trip; and with the foolishness of ignorance they absolutely undertook to manufacture dynamos in their shop. Finally, the inevitable result came. As to the system being abandoned, the statement is without authority. The fact is that the Sprague Company saw that its interests were imperiled by the parties who had obtained control of this road. We are in sympathy with the bondholders, and in co-operation with them to-day, and are endeavouring to restore the property to the condition in which it should be. We filed a bill to put it in the hands of a receiver, and take it away from these incompetent people, and have so far succeeded, that the only reason it has not been done is that every overture has been made to us, and every promise and assurance given that a radical change will be made in this incompetent management, and the road put in a condition so that this general subject may receive justice as well as the particular road directly interested. Within the next three months we will show to the people of Richmond some radical changes, and on the road that was the first electrical railway we will show them the best electrical railway in the world.

Mr. F. H. Monks, general manager of the West End Railway, Boston: The West End Railway Company has at this time in operation about 50 motor cars, operating some 30 miles of single track. It is giving great satisfaction to the public and to ourselves. It has been stated in a letter which has been read here to-night from President Whitney that the receipts on the Arlington line are very largely increased, and that the road is giving general satisfaction.

We are using the Thomson-Houston system. It is absolutely impossible for me to say what is the cost of operating the system, by reason of the fact that we have a contract with the Thomson-Houston Company, by which they practically agree to keep the motors in repair and the overhead line in repair; and hence I cannot say much as to the cost per mile for operating. That seems to me to be largely a matter depending on locality or the prices of coal, the price of labour, the price of real estate, etc. Many factors enter into the matter, so that each locality and each person in each locality must determine the question for himself. We are running a line from Park-square, in Boston, to Chestnut Hill and Allston, and we are taking a large number of passengers who formerly rode on the steam-cars, and we are giving great satisfaction. We are running cars on that line, in trains, on 15 minutes time; we meet with another line at Coolidge's corner, so called, and have a $7\frac{1}{2}$ minute line from that point in.

Mr. Wm. Richardson: We are all anxious to know how the West End Company is proceeding in this matter as to speed, the probability of its permanency, as regards the economy and efficiency of the plant, and generally whether the West End Company expects to so perfect this system of electricity that it will embrace all its lines in the city of Boston, or whether it has adopted it for use merely on its suburban roads.

Mr. Richardson: Has the success of the matter thus far been such that the directors of the company feel confident that they can in the future safely and practically operate their different lines by electrical power instead of horses; or is it still in the experimental stage?

Mr. Monks: I think I may safely state that the experimental stage has been passed. It is impossible for me to promise to a definite certainty that the whole of the 7,500 horses will be superseded by electricity. Sufficient it is to say that the company is launched upon the enterprise; and I think there is no question that there will be extensions made during the coming year in addition to those now contemplated.

Mr. Jenkins: Is there a greater or less expense in operating by electricity than by horses?

Mr. Monks: As I said before, I cannot say what the cost of operation is; I do not know the cost to the Thomson-Houston Company.

Mr. Richardson: I would like to ask whether, from the gentleman's experience with the system he speaks of as being operated at 15 minutes and $7\frac{1}{2}$ minutes apart, a road which needed to be operated with cars at intervals of two minutes on a road of four miles in length could, in his judgment, safely be equipped with this system of electricity, and could the system be safely depended upon to operate the road successfully.

Mr. Monks: In answer to the question let me say that on our Franklin Park division we have 2,000 horses. We have a very large business there; our July receipts being 114,000dols. If the same increase in our travelling takes place next summer with our electric cars that has taken place elsewhere with our electric cars, it is my expectation of being obliged to run cars at least 120 in the hour, in order to supply the demand. I have no hesitation, from what I have seen of the system now in use, in saying that it is my belief it will be perfectly practicable for us to do it in that way. We use the supplemental wire between the tracks, joining it to each rail, making a connection with the rail.

Mr. Richardson: Should a road now in existence and well constructed be reconstructed for the use of electricity?

Mr. Monks: I think so.

Mr. Richardson: Do you design the rail with the joints irregular or regular?

Mr. Monks: We propose to make it with joints meeting. We use a 78lb. Johnson rail on chairs, and we use a 66lb. Johnson rail on chairs; we also use some Providence girder rail. We make the joints meet because we think it avoids the possibility of a rolling motion, which I understand from steam railroad engineers has been the effect.

Mr. Richardson: Is there any reason to suppose that "live" wires will cause fatal results when persons come in contact with them?

Mr. Monks: No, sir.

Mr. Richardson: Our difficulty in Brooklyn in getting the right to put up overhead wires is the intense fear of their being dangerous to life and limb.

Mr. Monks: I think it is pretty generally understood in Boston that the pressure of current in our wire is not dangerous to life. As you know, in all electric roads we use a 500-volt current, and in many of the arc-lighting systems a 3,000-volt current is used. I have never heard of any serious injury resulting from contact with a wire carrying 500 volts.

Dr. W. L. Allen, of Davenport, Iowa: My experience has only been with a small road, operating five cars. We have run four cars steadily since August 14—a year ago. At that time we were laid up five days, as lightning burned out one of the armatures in the station. We have kept an account of all the repairs of all the commutators, gears, and all electrical apparatus. Our repairs have been on the five cars for renewals (the ordinary repairs have been included with operating expenses) such as commutators and gears for these five cars, 1,686dols. in 12 months up to Sept. 1. Our operating expenses have increased somewhat—that is, they were about 10,800dols. with horsecars, and have been 11,200dols. with these five electric cars. On that road we have a grade of $7\frac{1}{2}$ per cent. Our running time has been increased in this way; we ran 15-minute cars before; we run 12 minute now, and on busy days run on 10-minute headway. We can make the trip on the road 10 minutes out and 10 minutes back, being two miles and a quarter. The earnings have increased very largely. It would not make much of a figure compared with those other roads, but the percentage has been nearly 50 per cent.; the increase in gross earnings has been 23,000dols. against 15,000dols. The operating expenses have somewhat increased, taxes are increased, and insurance increased.

Our repairs are all included in the operating expenses, but the renewals were 1,680dols. We have had nothing to pay for armatures; we bought four field-magnets, costing about 20 dols. apiece. Most of the wear, in our experience, has been with the commutators. In June last we put on carbon brushes, and they proved very satisfactory, and the wear and loss has almost been done away with. One man attends to the motors, and he works on the commutators; and if some of the wires get loose on the armatures, he is able to fix them up. The cars make considerable noise, as a result, but the people do not seem to mind it. We use the Sprague system.

Mr. T. J. Evans, of Council Bluffs: I have been operating a road between Omaha and Council Bluffs for about a year. We ran during the first four or five months in the winter six motor and six trail cars. When the spring opened we started in with 10 motor and 10 trail cars. We average 120 miles a day to each train, running about 15 to 18 hours. We have operated that road at an expense of about four cents a mile, including everything except the interest and the wear and tear of the machinery. It includes the labour, materials, fuel, and renewals. We manufacture most of our renewals in our own shop. The length of the road was about 10 miles. During the summer we increased it to about 20, and put on 20 to 22 motor cars. Our expenses will be much less per mile now than before. The greater number of cars, of course, the less the proportionate expense. We use the Thomson-Houston system. I do not think there is much difference in the cost of operating either system. We have never had an accident. Our men have taken the current in its full force time and again. I have taken it without harm. We pay our motor men and conductors 2.50dols. a day. Last winter we did not have much snow, but in place of it something that was worse for electrical railways, and that was sleet. We had a great deal of foggy weather, and the moisture froze on the rail. It is far more difficult to operate the overhead wire with sleet on the wire than it is with snow on the surface. We never lost a train, however, but kept our schedule time. We apply scrapers in front of the trolley to scrape the sleet off, and sometimes a man would ride on the top of the car and strike the wire and break the sleet. We run about 18 hours, and the motor car makes about 120 miles a day. We have never burned out a motor on the line; we have short circuits, defective wires, and other minor difficulties; but we never had to send a machine away to be repaired. I recently completed a road in Ottawa, Ill. It has been in operation about six weeks. We run single motor cars with one man. That line costs a cent and a quarter per mile car for fuel. I have only eight motor cars; when they are increased to 12 or 15, it can be done for less than a cent a mile. About a week ago I took the eight motor cars, connected them together, and also four trail cars, making 12 in almost one line, and moved them, loaded with 830 people, four and a half miles from an 80 h.p. generator, and the train attained a speed of not less than seven and a half to eight miles an hour at any time, and at one time a speed of about 15 miles. We have a conductor, and his place is on the rear car. We have never had any trouble in stopping. We stop with an electrical car, as you are aware, rather easy. Our brakes work well; we have no difficulty in stopping two cars with one brake, of course, not so readily as if the conductor was on the rear car applying the brake at the same time. We depend on the brake on the forward car for stopping, but not altogether. When the signal is given to stop it is given by the conductor, and he winds the brake on the rear platform. Frequently the motor man stops without the conductor's knowledge. He does it with one brake, without any difficulty. When the motor man takes up a passenger without the conductor's knowledge he does it alone.

Mr. A. F. Breed, president Lynn and Boston Railroad Company: I think we were one of the first in our vicinity to adopt an electric road, which we commenced about a year ago last July, running about one mile. We operated that road during the summer, and it proved very successful. In the fall we commenced to build a road, just two miles long, and encircling a large population through the central part of the city. We go up a 9 per cent. grade and go down a 13 per cent. grade. We go over 11 sharp curves and switches in travelling over the circuit of just two miles, so that I think we get as good a test as is possible. We commenced operating that road about one year ago, and it has proven very satisfactory in all respects. We run by the overhead system. The 13 per cent. grade is about 1,500 feet long. The other day, when there must have been 35 passengers on the car, as a little experiment, I told the driver to stop the car on the steepest part of the grade and reverse his current and go back, which he did. He stopped the car on the steepest part of the grade and moved the car back perhaps 100ft. I think on the 9 per cent. grade we could make perhaps six or seven miles an hour. In the case of that particular line the people did not like to run by horses on account of the steep grades, and the business was very light. I think the increase is large on that part of our system. I should say it was 15 to 25 per cent.

Mr. S. K. Short, of the Short Electric Railway Company: I want to call attention of the delegates to one or two points in connection with our system of electric railways. We use an armature which is large in diameter, and that gives us, with the rotary feeder, a high speed of the bobbin of the armature. This enables us to run our gears at a very low speed. The pinions on the shaft are large, and we have cars that have been in regular service a year without these gears showing much wear, and we believe it is the slowness of speed which saves them. That has been a very serious difficulty, connecting the motor with the axle of the car wheel. We find that by the slow movement we can gain an advantage in wear. The bobbins on the armature are all separated, so that no excessive heat can be developed in it. We will guarantee that our armatures will not burn out. With these objections removed, these excessive repairs done away with, and these electrical difficulties overcome, it makes the motor a very economical means of moving street cars. Our expenses for operating in Huntington, W. Va., are about two and a half cents per car mile, including everything but wages. In that city the cost of drivers and conductors

is low, about 1.50dols. a day. We make an average of about 130 miles a day. We run our cars at a very high rate of speed in the suburbs. We use two systems of overhead construction. We have one system with two wires overhead. This we consider the most reliable and safest system when the constant current is used. We also use the single overhead wire construction, with the rail return. We use carbon brushes on the motors, and also removable segments on the commutators, so that they are not destroyed when they wear down. We simply take off the removable segments, and replace them with new ones. We put up a construction and equipment of a mile and a half for the St. Louis Railroad Company. We are now extending the system three miles, and adding eighteen more cars. It is the intention to run inside of 10 days. The system was successful and was operated successfully, but the construction was insufficient for the road. It was on the main portion of the Broadway line, which has a very heavy traffic.

Mr. Johnson, of the Sprague Company, was asked about a rumour that the Sprague Company had transferred its business to the Thomson-Houston Company. Mr. Johnson replied that while his company could not undertake to reply to all the rumours made concerning the company and the operation of its system, this particular rumour was absurd, and he did not think anything more need be said. However, in justice to the Sprague system, he wished to call attention to the fact that when Mr. Sprague designed the apparatus for the Richmond road he had no predecessors to tell him how to do it. He did it, the road worked, and as a result there are some 300 electrical roads in operation in the country to-day. This, he considered, was the best evidence that what Mr. Sprague did at Richmond had merit. The fact was that electrical propulsion had become an established industry, and he thought there was enough business for all.

WOLVERHAMPTON.

The Wolverhampton Electric Light and Power Company, Limited, and the Midland House-to-House Company, Limited, having served notices upon the town clerk of their intention to apply to the Board of Trade for provisional orders to supply electricity for public and private purposes within the borough of Wolverhampton, the General Purposes Committee of the Council of that town have prepared a report on the subject, and the Council met yesterday week to receive it. The Mayor presided. The committee's report, after referring to the revoking by the Board of Trade in 1884 of the provisional order granting lighting powers to the South Staffordshire Electric Light Company, went on to show that communications had been addressed on September 29 of the present year by the committee to the two companies now about to apply, to the effect that the committee had under their consideration the expediency of recommending the Council to obtain lighting powers themselves, but that they did not desire to adopt this course if the companies would agree to certain conditions. Neither of the replies of the two companies with regard to these conditions was considered satisfactory, and the committee had consulted Mr. J. N. Shoolbred, M.I.C.E., whom the Corporation consulted also in 1882. The committee had now to recommend that the Corporation should oppose the application of the two companies, and apply for a provisional order to light the borough themselves. The report continued: "As a compulsory or experimental area in this borough, the borough engineer and Mr. Shoolbred have, with the approval of your committee, selected, with certain additions, the area known under the South Staffordshire order as the compulsory area, and which embraces the principal streets in the heart of the town, and amongst other public buildings the following: The Town Hall, Market Hall, Exchange, Drill Hall, Agricultural Hall, Theatre, Free Library, Liberal Club, Conservative Club, Art Gallery, St. Peter's Church, Queen-street Chapel, Darlington-street Chapel, and Baptist Chapel. . . . While your committee cannot at present favourably compare the cost of supply of electricity with that of gas, still the great advantages of electric lighting as compared with gas lighting as affecting health, goods, furniture, books, decorations, and the absolute freedom of the electric light from explosions and personal injury, lead your committee to think that it would be unwise to allow any company to absolutely control within this borough for a period of 42 years what may prove to be the light of the future." Mr. Shoolbred's report, which was also presented, showed that Manchester, Nottingham, Oldham, Leicester, and Bedford each proposed to take the lighting into their own hands. As to the choice of a suitable generating station, the Horse Fair Ground (where a considerable area of back land appears to be available) and some land in Canal-street (near to its junction with Railway-street), both the property of the Corporation, appeared to be suitable for the purpose. Generating plant for the supply of electricity on the continuous-current system, to the extent of supplying about 5,000 lamps of 15 c.p. (as is the popular though hardly accurate mode of describing such installations), would seem to meet the present requirements of the district selected. He estimated the cost of a central station and the system of public distribution at about £20,000; but the exact sum would be dependent upon the con-

ditions of the market, more especially as to copper and iron, and the demand for electric machinery. With respect to the working expenses of the installation, they were somewhat difficult to estimate with preciseness, mainly in consequence of the uncertain state of the labour question, but also varying with the actual number of lights in use and the hours of maximum demand (both of which matters are found to vary considerably with the nature of the district). Of these causes the first-named was probably the most important; shorter hours of labour—which, of course, meant an increased working staff—might add some 30 or 40 per cent. to the present rate of working expenses. Then, again, much depended upon the system upon which the electric current was generated, whether upon the continuous or upon the alternating current system. With the latter the engines must be kept going, without interruption, as long as the current is required; this meaning, of course, a large working staff and a heavy coal bill, while with the former system (advocated in this report) the current could be supplied from accumulators during the night, and at other times when the demand was small without the assistance of the engines, and with a proportionate economy also in the working staff. Taking all matters into consideration, and judging from actual experience under somewhat similar circumstances, the working expenses proper of the above-described installation might be set down at £1,500 per annum.

A report by the town clerk (Mr. Horatio Brevitt) to the committee on the legal aspects of the matter was also presented. The Council had also before them a report by Mr. R. E. W. Berrington, the borough engineer. The Mayor spoke in favour of the recommendations of the General Purposes Committee, and moved a long resolution that the Council should apply for a provisional order to supply and provide electricity for all public and private purposes within the borough; that the area defined on the plan prepared by the borough surveyor be the compulsory area for an initial installation; that the General Purposes Committee be empowered to seek professional aid in deciding what system to adopt; and that steps should be taken to oppose the application of the two electric light companies already named for provisional orders to supply electricity within the borough. The Mayor said everyone knew that Mr. Chamberlain, in guiding the Act of 1882 through the House of Commons, was particularly careful to call the attention of the country to the fact that, whilst not wishing to startle companies, he yet desired to prevent such monopolies as had been created by some gas and tramway companies, whereby local authorities had been burdened. He did not intend his remarks to apply to the companies who were at present concerned; but formerly the effect of granting concessions had been simply to give to the applicant something saleable—that was to say, the powers were obtained to come into a town and occupy certain ground, and these powers were sold to other companies. In the *Birmingham Daily Post* of that morning there was an account of a transaction of that sort taking place at Birmingham. He did not think that was a thing which a local authority ought to allow to take place. It was better for a corporation to take the matter entirely into their own hands at once. There was no doubt that electric lighting was coming to the fore, and it was right that the town should go thoroughly into the matter. Alderman Bantock seconded the resolution, and discussed the merits of the alternating and continuous systems respectively. The committee, he said, had had the benefit of the views of Mr. Parker, of the Electric Construction Corporation, whose excellent invention—the new electric tramcar—had been tried in Birmingham the previous day. They would see from the papers that morning how successful this car had been. Some of them in Wolverhampton would not regret if the gas dividends should fall, because he believed the progress of electricity would tend to the greatest good of the greatest number. Mr. Mander supported the resolution, saying the Americans had lighted scores of cities, but England with its proverbial caution had held back. Perhaps she had gained something by that, but at any rate now was the time to hold back no longer, but to go forward. He had had the pleasure of riding on Wednesday upon the new electric car that was tried at Birmingham, and which, it was stated, was the first completely successful electric tramcar used in this country. It was undoubtedly an immense improvement upon the steam-car, and the general impression among those who witnessed the trial seemed to be that the immediate adoption of the electric car in Birmingham and elsewhere was extremely probable. He had tried the electric light in his own house for more than a year, and it had worked without a single hitch. Mr. James Saunders also supported the resolution, pointing out that with gas at 2s. 4d. per 1,000ft. it was quite time for Wolverhampton to take steps towards securing the electric light. Leeds had authorised the expenditure of about £20,000 for electric lighting, though they had to pay only 1s. 9d. for gas, and the electric light was likewise being adopted for Plymouth, where also gas was much cheaper than at Wolverhampton. Mr. Willcock and Mr. Shepherd spoke in support of the proposition. Mr. Dawson scarcely thought the canal locality spoken of in the reports was a good place, but the Mayor pointed out that it would be convenient

for obtaining coal supplies. The resolution was carried unanimously.

DUNDEE.

The Committee of the Dundee Gas Commission who were appointed to consider the question of electric lighting have just issued their report in the following terms:

The committee beg to submit the following particulars as the result of their enquiries and visits: They resolved, in the first place, to view and investigate only the best known and most approved systems of electric lighting, and to do this visited London and Paris. In making the inspections they were kindly received and assisted by several well-known electrical engineers. In London, at Deptford, there is to be seen the largest installation of electric lighting in the world, and here your committee spent a considerable time. These large works are quite an exhibition of progress and enterprise. To give you some idea of their magnitude and completeness, we note a few details. The works are the property of the London Electric Light Corporation, Limited, the engineer of which is Mons. de Ferranti. At the present time they employ 24 steam boilers of the Babcock and Wilcox type. These extensive works are arranged to light at once 120,000 lights of 10 c.p. each; but it is the ultimate plan of the company to light 2,400,000 lights, and for this purpose they are at present erecting two large dynamos 35ft. diameter, and which are to be propelled by two engines of 10,000 h.p. each. The dynamos at present employed are two in number, and are known as the "Ferranti," and, we were informed, are giving good results wherever they have been introduced. All the buildings in and about this company's works are of a most substantial and permanent description, and it was quite apparent, both here and in the other works visited, that the promoters have every confidence in the success of the new light. The cables are all laid underground, in built channels prepared for their reception, which channels have openings with cast-iron covers at convenient distances to permit of the ready examination and repair of the cables. Meters are also attached to the service cables, by which the exact quantity of current supplied can be ascertained. Every improvement in the various house connections was examined, and the great facility which exists for the laying in of the electric light to any apartment irrespective of its description or size was very apparent. The smallest office can be as beautifully illuminated as the grandest hall, picture gallery, or hotel. One means of economy in the supply of the new light, and which has not been introduced to any extent in gas supply, is the speedy and simple means for lighting and extinguishing the incandescent light. A small knob or switch is placed at a convenient point near the entrance to each apartment. When a light is required the knob is touched, and all is brilliantly illuminated; and the moment the room is vacated the process is reversed, and instantly all is dark. This must prove a very important point, especially in domestic lighting.

The committee next visited the electric lighting works at Brompton, the property of the House-to-House Electric Light Supply Company, Limited. Here the committee found the electric light was being supplied to a considerable portion of London. At present the light is only supplied from dusk up till one o'clock a.m.; but they were informed that when the demand is sufficiently large (and it is daily increasing) the lighting will be supplied during the whole 24 hours. These works resemble the ones previously described, in so far as the permanent nature of the structure is concerned. About £35,000 have already been expended on these works, and which embrace three engines of 200 h.p. each, and which propel three Lowrie-Parker alternating-current dynamo machines with three exciters. These machines are of the high-tension kind, but before the current reaches the consumer it passes through a converter, by which means the E.M.F. is reduced from 2,000 volts to 100, or even less. The safety of the consumer is further assured by the employment of a safety fuse preventing any unforeseen increase of force in the current reaching the premises being lighted. One very interesting and valuable improvement in the apparatus connected with electric lighting was adopted here. It consists of a regulator, by which the supply of the electric current is regulated according to the demand. Thus, if 1,000 lights are being supplied, and this number is suddenly reduced to 100, to the same extent will the supply of the current be automatically reduced, thereby securing a steadiness of light which is so essential to successful illumination, and also securing a saving in the cost of production. This company employ metal pipes resembling gas mains to contain their cables underground. These pipes have openings at certain distances to allow of the inspection of the cables as previously described. The company is in thorough-going order, and all the details, both in regard to machinery and management, were examined, and seemed very complete. A chart on a large scale, which is almost daily being added to, is conveniently situated

in the operator's room. Upon this chart is marked every cable under the company's control and every consumer supplied, showing at a bird's-eye view the extent of the company's area of supply.

The committee next visited Paris, where, through the kindness of M. Edouillard, and under his personal guidance, the electric lighting machinery and apparatus at work in the Exhibition were examined, and, it is scarcely necessary to say, much admired. Here both the arc and incandescent systems are at work—the former for external illumination and the latter for internal. In most cases where the arc light has hitherto been adopted its unsteadiness has been very disappointing, but here no such defect was observable, owing to the fact that a large margin of power existed in the engines, thereby maintaining at all times a perfectly steady motion. The internal illumination derived from many thousands of incandescent lights, and at remote distances from the source of production, was excellent. Every department was, by similar appliances to those already explained, completely under control, and although this installation is so vast in its extent and so varied in its ramifications, there seemed neither fault nor failure anywhere. The installation of electric lighting in Paris, however, to which your committee paid special attention, was the one at present being carried out by the public authorities there. This is situated under the markets, in a well-built and fireproof sunk area. Being public property, no rent for the ground will be payable, and this alone will assist in the economical supply of the light. It occurred to your committee that if electric lighting is to be introduced into Dundee, the installation should be proceeded with on the lines indicated. It was noticeable in this public installation in Paris that there was a total absence of everything ornamental. The machines and engines were well made, and like their work; the boilers were such as to be most economical of space; facilities were introduced for bringing the fuel as cheaply and quickly to the furnaces as possible; and the surroundings as a whole impressed the committee with the careful and practical manner in which they had been planned and carried out, so that the light could be produced at the lowest possible rate, and at the same time ensuring that the capital expended had been expended on plant of a thoroughly substantial and durable nature, and on buildings of the most permanent character. As the machinery here had not been started when your committee viewed it, the result of the lighting cannot be definitely stated; but there was no doubt in the minds of the French engineers that everything would result as expected.

While in Paris the committee had several opportunities of examining the method of laying and repairing the cables in the public streets. These are all laid underground in the same way as already described, and although, while the work is being done, the usual obstruction to traffic and annoyance to passengers are experienced, still these are not greater than they would be in the case of laying a gas main, and in this respect, generally speaking, it may be taken as correct that the laying of electric mains and services and gas mains and services are synonymous terms.

Before concluding this report it seems to us desirable to give you any information in our possession as to the cost of electric lighting as compared with gas. This has been difficult to arrive at, and must depend very much on the circumstances of each individual case. The larger the number of lights to be supplied the cheaper will it be produced, and *vice versa*. So far as could be ascertained in London, the cost of the light from electricity equal in illuminating power to the light from 1,000 cubic feet of London gas was 3s. 9d. The average cost of London gas is about 2s. 6d. per 1,000 cubic feet. But we must not forget the fact that London gas is only equal in illuminating power to 16 standard candles, whereas in Dundee it is equal to at least 26 candles. Therefore, if the value of 16-candle gas is 2s. 6d. per 1,000 cubic feet, 26-candle gas is worth 4s. 0³d. per 1,000ft.; but the Dundee price is only 3s. 4d. per 1,000ft. net. If we now adopt the simple rule that the light from electricity is equal to 3s. 9d. per 1,000 cubic feet of 16-candle gas, it will work out 6s. 1⁴d. per 1,000 cubic feet of 26-candle gas. Putting this figure against the above-quoted 3s. 4d. (being Dundee price), you have a difference in price in favour of gas in Dundee of 2s. 9¹d. per 1,000ft.

The fact must not be concealed that the electric light possesses many advantages over gas, notably amongst these being the total absence of any vitiation of the atmosphere of the apartments lighted, and the almost complete absence of any heating power. These are doubtless most valuable qualities, but whether they are worth the difference in price indicated is a question your committee cannot answer. Your committee have approached the question of electric lighting in an impartial spirit, knowing as they well did that, if this means of illumination is to be taken up by the Dundee public, it should be so with the fullest possible information and in the interests of the whole community. They consider that in resolving to supply the new light themselves the gas commissioners, who represent the public, and the public alone, act wisely, as the lighting in Dundee should be done by the gas commissioners.

They recommend this the more strongly because there is ample space at the gas works for the erection of such buildings as would be required for accommodating the machinery necessary for producing the light; and they also believe that the electric light could be produced most economically under the same management as exists at present at the gas works. In applying for powers to do so, the commissioners should proceed by Bill rather than by provisional order, as under a Bill it is possible to get larger and more comprehensive powers in the interests of the community than under a mere provisional order. The committee have satisfied themselves that the question is now no longer one of experiment—it is a reality, and one which at once is a competitor of coal gas; but how near the future may be when electricity will be adopted for lighting purposes, and also for the transmission of power, it is difficult to say. Of one thing the committee are assured, judging by the installations they have witnessed (and they are the best in the world), there is no difficulty attending its introduction, and in their opinion its adoption can only be delayed and its extended use hindered by its cost. In concluding this report the committee would express their indebtedness to the following gentlemen for assisting them in making their enquiries: Mr. Malcolm, London; Mr. Alexander Siemens, London; Mr. Hammond, London; Mons. de Ferranti, London; Mons. Edouillard, Paris; and others.—JOSEPH LINDSAY, Presses; JAMES GENTLE. Dundee, 30th October, 1889.

This report was considered at a special meeting of the Gas Commission on Monday, when it was recommended that the Town Council should apply for power to manufacture and supply electric light.

PHYSICAL SOCIETY.—Nov. 1.

Prof. REINOLD, F.R.S., President, in the Chair.

Mr. T. A. Garrett was elected a member of the society.

The following communications were read:

"On a New Electric Radiation Meter," by Mr. W. G. Gregory. The meter consists of a long, fine platinum wire attached to a delicate magnifying spring of the Ayrton and Perry type, and stretched within a compound tube of glass and brass. At the junction between the wire and spring a small mirror is fixed. When the tube is placed parallel to a Hertz's oscillator in action the mirror is turned in a direction indicating an extension of the wire. The arrangement is so sensitive that an elongation of $\frac{1}{100,000}$ of a mm. can be detected, and when placed at a distance of a metre from the oscillator the apparent extension is such as would correspond to a change of temperature of 0.003deg. C. By its aid the author has roughly verified Hertz's statements that at considerable distances the intensity of radiation varies as the inverse distance, but before he can proceed further it is necessary to greatly increase the sensibility of the apparatus, and with a view of obtaining some suggestions in this direction he exhibited it before the society. Prof. Perry asked if the E.M.F. required to produce the observed results had been calculated. He also believed that the sensibility might be increased by using copper instead of platinum, and replacing the spring by a twisted strip. Mr. Blakesley enquired whether the effect of increasing the capacity of the ends of the wire had been tried. Mr. Boys said that if the observed effect was due to rise of temperature he would like to see it measured thermally. He also thought the effect might be due to extension caused by rapid electric oscillations in some such way as the elongation of an iron bar caused by magnetisation. In answer to this, Prof. S. P. Thompson said the matter had been investigated experimentally, but with negative results. Prof. Herschel suggested the use of a compound spring, such as are used in Breguet's metallic thermometers. In reply, Mr. Gregory said he had estimated the E.M.F. by observing that a Leclanché cell through 50 ohms produced about the same result. No improvement in sensitiveness was obtained by using copper wire or by increasing its capacity, and attempts to measure the rise of temperature by an air thermometer had been given up as hopeless. The President, in thanking the author for his paper, congratulated him on the ingenuity and courage displayed in producing an apparatus to measure such microscopic quantities as are here involved.

"On a Method of Driving Tuning Forks Electrically," by Mr. Gregory. In order to give the impulses about the middle of the stroke, the fork is arranged to make and break the primary circuit of a small transformer, the secondary circuit of which is completed through the electromagnet actuating the fork. The prongs of the fork are magnetised and receive two impulses in each period. Another device was suggested, where the prongs respectively operate contacts which successively charge and discharge a condenser through the coils of the actuating magnet. Prof. S. P. Thompson said the methods, if perfect, would be of great service, and suggested that a fork so driven be tested optically by comparison with a freely vibrating one. He regarded the mercury contacts used as objectionable, for their capillarity and adhesion would probably cause the impulses to lag behind the appointed epochs. Prof. McLeod remarked that lissagous figures gave a satisfactory method of testing the constancy of period and could be readily observed without using lenses, and in reference to liquid condensers, suggested by the author for his second device, said that platinum plates in sulphuric acid were found to disintegrate when used for this purpose. He thought lead plates would prove suitable. Prof. Jones, who read a paper on a similar subject in

March last, said he now used bowed forks with which to synchronise the speed of the disc there described, and the frequency is determined by causing the disc to complete the circuit of his Morse receiver once each revolution.

"On a Physical Basis for the Theory of Errors," by Mr. C. V. Burton, D.Sc. After pointing out that the law of error for any particular measurement depends on the nature of the conditions governing such measurement, the author considers several simple cases, and deduces their curves of error. A kinematic method of combining two or more independent errors, each following known laws, is then described and applied, and the general formula obtained leads to Laplace's law of error in the case of an infinite number of similar errors. Referring to most advantageous combinations of measures, it is shown that the method of least squares is only a particular solution of the general equation, and is derived by assuming the individual errors to conform to Laplace's law. Subjective errors are next considered, and, in conclusion, the author says that "the law of error in a set of observations depends on the nature of each special case, and what may be called the probable law of error is determined by our knowledge of the conditions. The combination of three or more sources of error of comparable importance gives, in general, a law not seriously differing from that of Laplace, so that the method of least squares will be practically the most advantageous, except where a single source of error with a very different law is predominant above all the rest."

"A Note on the Behaviour of Twisted Strips" by Prof. J. Perry, F.R.S., had been prematurely announced by mistake, and he accordingly gave only a brief outline of the paper. In a previous communication Prof. Ayrton and the author enunciated a working hypothesis in which the strips were imagined to be split up into pairs of filaments, each pair acting as a bifilar suspension. The resulting formula for the rotation produced by a given load did not agree with experiment, and quite recently the author had recognised why the formula was incorrect. The bifilar law they had assumed was only true for small twists, but he now saw another method of treatment by which he hoped to verify the formula derived from experiment before the next meeting. Prof. Fitzgerald reminded Prof. Perry of a method of attacking the problem suggested by the speaker some time ago, in which each filament was supposed to be wrapped round a smooth cylinder, and said that on working it out the formula was found to be very complicated. Mr. Trotter thought the pairs of strips might be regarded as twisted ladders, and Mr. Gregory said this suggestion reduced the problem to a series of bifilar suspensions, which had already been worked out.

"On Electrifications due to Contact of Gases and Liquids," by Mr. J. Enright. For some time past the author has been studying the electrical phenomena attending solution, by connecting an insulated vessel in which the solution takes place with an electrometer. As a general rule, no effect is observed if nothing leaves the vessel, but when gases are produced and allowed to escape the vessel becomes charged with + or - electricity, depending on the nature of the liquid from which the gas passes into the air. As an example, when zinc is placed in hydrochloric acid, the deflection of the electrometer is in one direction whilst the liquid is chiefly acid, but decreases and reverses as more and more zinc chloride is produced. From such observations the author hopes to obtain some information relating to atomic charges. Owing to the lateness of the hour the latter portion of the paper and the discussion on it were postponed until next meeting.

COMPANIES' MEETINGS.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.

The thirty-second ordinary general meeting of the shareholders of the Brazilian Submarine Telegraph Company, Limited, was held on Wednesday at Winchester House, Old Broad-street, Sir James Anderson (in the absence of Viscount Monck) in the chair.

The Chairman, in moving the adoption of the report, said that, as usual, there had been ups and downs in the period under review. They had lost £20,000 in their receipts, as compared with the previous half-year, although they had made nearly £4,000 more than in the corresponding half-year. This great reduction in their revenue was due to the interruption in the Western and Brazilian lines. At present all the cables were working, and their revenue was very good. Whether their friends of the Company would be allowed to duplicate their cable or not seemed to be a knotty question, but they were using every endeavour to do so, and if this Company could help them, they would be glad to do so. On the other hand, they had a growing traffic, and £75,000 invested in the West African cables, which were now earning a revenue. These had been extended to the Cape of Good Hope, and this Company had a joint purse with the other companies working on that coast; so that the revenue in the half-year amounted to £3,300, and Mr. Fuller, their managing director, estimated the revenue for the current 12 months from that cable at £14,000.

Mr. St. J. Brodrick, M.P., seconded the adoption of the report.

In reply to a shareholder, the Chairman said with regard to the rumours of cables to be laid to the River Plate, that if the Argentine Government thought proper to give a guarantee, he knew no way of preventing it; but the matter had not yet come before them in such a way that they could grapple with it. There were always men seeking to make money, and if they could get a subsidy from the Government it would be a poor day for their Company; but still he did not despair.

The report was then adopted, the retiring Directors and Auditors re-elected, and the customary votes of thanks accorded.

SWAN UNITED ELECTRIC LIGHT COMPANY.

Seventh annual report of the Directors, to be presented at the ordinary general meeting of the Company, to be held at the Cannon-street Hotel, London, on Thursday, November 14, 1889, at 2 p.m.

The accounts, which are herewith presented, are for the year ending September 30, 1889. After paying all current charges, and making ample allowance for depreciation of plant, there is a credit balance of £21,042. 8s. 1d., to which must be added the credit balance of £10,052. 8s. 11d. brought forward from the last accounts, making a total of £31,094. 17s. The Directors will recommend the shareholders to declare a dividend of 6 per cent., which will absorb £22,208. 0s. 9d., to be distributed to the shareholders in accordance with clause 77 of the articles of association. The litigation in Germany still drags on, and, until some conclusion is arrived at, it is difficult to foresee whether a sound and remunerative business can be carried on in that country. The shareholders are aware that Germany is the only country on the Continent of Europe in which the Company now manufactures and sells lamps. The Compagnie Générale des Lampes Incandescentes have established a new factory in Paris, which was brought into work last July, in which lamps are now being manufactured on a considerable scale. During the first six months of its existence the Company worked under considerable disadvantages, having had to purchase the lamps required for their business, so that a small dividend only was earned, but there is every reason to hope that they will develop an increasing and profitable trade. The Directors who retire by rotation are Mr. J. S. Forbes and Mr. E. W. Batt, who, being eligible, will offer themselves for re-election. Messrs. Welton, Jones, and Co., the auditors, will also retire, and will offer themselves for re-election.

BALANCE SHEET, 30th SEPTEMBER, 1889.

Dr.	£	s.	d.	£	s.	d.
To Share Capital—						
19,750 Shares of £5 each fully paid	98,750	0	0			
78,949 Shares of £5 each £3 10s. paid	276,321	10	0			
				375,071	10	0
„ Forfeited Shares				3,530	0	0
„ Sundry Creditors				2,357	15	6
„ Balance 30th Sept., 1887	1,720	7	11			
„ „ 30th Sept., 1888	8,332	1	0			
„ „ 30th Sept., 1889	21,042	8	1			
				31,094	17	0
Cr.				£412,054	2	6
By cost of Patent Rights, etc., represented by Shares in Edison and Swan United Electric Light Company, Limited, with £208,478 paid; Shares in La Compagnie Générale des Lampes Incandescentes with £30,489. 8s. 3d. paid; patents held by the Company for Germany, India, etc., as per last Balance Sheet	329,911	17	8			
„ Additional expenditure thereon ..	422	13	7			
				330,334	11	3
„ Outlay on Factories, Plant, etc., as per last account	4,317	5	8			
Less Depreciation	1,863	9	1			
				2,453	16	7
„ Sundry Debtors				3,324	5	9
„ Stock on hand				3,770	8	6
„ Investment in Prussian Consols. Cost				5,120	0	0
„ Investment in New 2½ per cent. Consolidated Stock. Cost				29,004	19	6
„ Cash on Deposit and in hand ..				38,046	0	11
				£412,054	2	6

PROFIT AND LOSS ACCOUNT, YEAR ENDING SEPTEMBER 30.

Dr.	£	s.	d.	£	s.	d.
To Stock, October 1, 1888				9,676	16	9
„ Purchase				1,615	10	7
„ Office Expenses, Directors' Fees, Rent, Salaries, etc.	3,944	17	9			
Mr. Swan's Salary £623 5 9						
Less proportion payable by the Edison and Swan Company	373	19	5			
				249	6	4
				4,194	4	1
„ Wages and Expenses at Factories ..				5,290	15	2
„ Depreciation				1,863	9	1
„ Sales Ledger Reserve				100	0	0
„ Balance				21,042	8	1
				£43,783	3	9
Cr.				£	s.	d.
By Sales, less Commissions and Allowances				17,665	0	6
„ Transfer Fees and Interest				1,344	11	3
„ Dividend to December 31st, 1888, received from La Compagnie Générale des Lampes Incandescentes, less Income Tax				885	11	0
„ Dividends to June 30th, 1889, received from the Edison and Swan United Electric Light Company, Limited, less Income Tax				20,117	12	6
„ Stock, September 30th, 1889				3,770	8	6
				£43,783	3	9

NEW COMPANIES REGISTERED.

Llanelly Electric Light and Power Company, Limited.—Registered by Waterlow and Sons, London-wall, E.C., with a capital of £15,000 in £1 shares. Object: to generate and distribute electricity, electromotive force, or other similar agency, for the purpose of lighting streets, public places, etc. There shall not be less than five nor more than eight Directors. The first to be appointed by the subscribers. Qualification: £250.

National Electric Supply Company, Limited.—Registered by S. Learoyd and James, 12, Coleman-street, E.C., with a capital of £100,000 in £5 shares. Object: to carry on, either in England or elsewhere, the business of electric lighting, and to produce and supply electricity or electric currents and forces. The first subscribers are:

	Shares.
F. V. Wentworth, Wentworth Castle, Barnsley.....	73
B. C. Wentworth, Wentworth Castle, Barnsley.....	24
S. D. Waddy, Q.C., 54, Temple, E.C.....	48
D. Rylands, Shepcote, Barnsley.....	120
C. H. Cobbold, Rose-hill, Dodnorth.....	60
T. Robinson, Broom-hill View, Moor-Allerton, Leeds ...	60
W. Emmott, Halifax	60

There shall not be less than three nor more than seven Directors. The first are C. H. Cobbold, D. Rylands, T. Robinson, and W. Emmott. Qualification, 50 shares. Remuneration: Chairman, £200; other Directors, £100 each.

CITY NOTES.

West Coast of America Telegraph Company.—The receipts for the month of October amounted to £7,725.

Brazilian Submarine Telegraph Company.—The receipts for the week ended November 1 amounted to £4,506.

Eastern Extension, Etc., Company, Limited.—The traffic receipts for October were £45,679, an increase of £7,019.

Great Northern Telegraph Company.—The receipts of this Company for the month of October amounted to £26,000.

Eastern Telegraph Company.—The traffic receipts for October were £62,981, as against £55,742 for the same period of 1888, or an increase of £7,239.

South of England Telephone Company, Limited.—The Directors have declared a dividend of 6 per cent. per annum on the preference shares for the half-year ending October 31.

Swan United Electric Light Company, Limited.—The Directors of this Company have decided to recommend a dividend of 6 per cent. for the year ending September 30 last.

Western and Brazilian Telegraph Company, Limited.—The Directors of this Company, after placing £7,500 to the renewal fund and £5,600 to the debenture redemption fund, recommended a dividend of 6s. per share, tax free, being at the rate of 4 per cent. per annum, for the six months ended June 30. The receipts of the Company for the week ended November 7, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,112.

West India and Panama Telegraph Company, Limited.—The report of this Company for the half-year ended June 30 shows an available balance of £26,681. The Directors have placed £2,000 to reserve, leaving £24,681, out of which it is proposed to pay on the first preference shares the balance of arrears of dividend, or 6s. per share, and a dividend for the six months to June 30 of 6s. per share. On account of arrears of dividend on the second preference shares to June 30 they propose 10s. per share, £1,609 being carried forward. The receipts of the Company for the half-month ended October 31 were £2,717 against £2,767.

Companies of the Month.—The following electrical companies have been registered during the past month:

Birmingham Safe Deposit Company, Limited, £5 shares...	20,000
Electrical Accessories Company, Limited, £1 shares	25,000
Electrical Supply Company for Spain, £5 shares.....	100,000
Electric Arms and Ammunition Syndicate, Limited, £100 shares	40,000
John Wild and Company, Limited, £5 shares.	10,000
Llanelly Electric Light and Power Company, Limited, £1 shares	15,000
National Electric Supply Company, Limited, £5 shares ...	100,000

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name	Paid.	Price Wednes- day
12 Feb.	1/2	Anglo-American Brush E.L.	—	4½
12 Feb.	2/0	— fully paid	—	5½
14 Nov.	0/4½	Con Telephone & Main ...	1	½
27 July	10/0	India Rubber, G. P. & Tel.	10	19½
.....	...	House-to-House	4½	5
.....	...	Metroptn Electric Supply	—	3½
.....	...	London Electric Supply ...	5	4½
.....	...	Swan United	3½	5
2 July	12/0	Telegraph Construction ...	12	43½
2 July	6/0	— 6%, 1889	100	105
...	...	National Telephone	5	6½

PROVISIONAL PATENTS, 1889.

OCTOBER 28.

16978. **Improved arrangement of conductors for electric series traction.** John Macintosh Mackay Munro, 154, St. Vincent-street, Glasgow.

17004. **Improvements in electric terminals and switches.** Henry Inkson Harris, 21, Cockspur-street, London. (Complete specification.)

OCTOBER 29.

17045. **The insulation of electric wires or cables.** Frederick Morley, 7, Hobson-street, Cambridge.

17060. **Improvements in electrical furnaces and their manipulation.** Thomas Packer, Newbridge, Wolverhampton, Staffordshire.

17062. **A miner's or safety lamp and battery.** William F. G. Ward, 56, Mann-street, Walworth.

17088. **Improvements in means for operating mechanical devices electrically.** William Edwin Irish, 52, Chancery-lane, London. (Complete specification.)

17115. **Improvements in electro-magnetic telegraph apparatus.** Franz Xaver Bachmann, 22, Southampton-buildings, London. (Dated October 30th.)

17118. **Improvements in and relating to electrical transformers or converters.** Leonard Paget and Charles Jacob Kintner, 45, Southampton-buildings, London. (Complete specifications.)

17124. **Improvements in interrupting devices for electric circuits, applicable for protecting electrical apparatus connected in such circuits.** William Phillips Thompson, 6, Lord-street, Liverpool. (The Westinghouse Electric Company, United States.)

17142. **Improvements in electro-magnetic induction apparatus for transformers, generators, or motors.** Louis Bollman, 28, Southampton-buildings, Chancery-lane. (Complete specification.)

OCTOBER 30.

17205. **Improvements in the process for obtaining zinc by electrolysis.** Alexander Stanley Elmore, 28, Southampton-buildings, London.

17221. **Improvements in electric telephonic apparatus.** Herbert Luzerne Todd, Wilbur Fisk Melbourne, James Thompson, and Ranulph Edward Montague Mosyn, 47, Lincoln's-inn-fields, London. (Complete specification.)

OCTOBER 31.

17252. **Improvements in electric secondary cells.** François Marie Arthur Laurent-Cély and Illius Augustus Timmis, 2, Great George-street, Westminster, London.

17260. **Improvements in holders for incandescent electric lamps.** William Henry Oakley, 55 and 56, Chancery-lane, London.

17276. **An improved socket and adapter for electrical purposes.** George Donovan and Walter Donovan, 1, Queen Victoria-street, London.

NOVEMBER 1.

17317. **Improvements in electric measuring and regulating apparatus for use with alternate currents.** Walter Thomas Goolden and Sydney Evershed, Woodfield-road, Harrow-road, London.

NOVEMBER 2.

17375. **Improvements in and relating to electric arc lamps.** George Edensor Dorman, The Hawthorns, Stafford.

17387. **Improvements in electric meters.** Joseph Oulton and Joseph Edmondson, Central Chambers, Halifax.

17424. **Improvements in joints for armoured electric conductors.** Joseph Devonport Finney Andrews, 28, Southampton-buildings, London.

17425. **Improvements in electric arc lamps.** Henry Harper, 191, Fleet-street, London.

SPECIFICATIONS PUBLISHED.

1888.

14489. **Electric lighting.** Von Moese-Nollendorf. 8d.

14888. **Electric cranes.** Hollock. 8d.

16479. **Secondary batteries.** Lake (Walter). 8d.

17568. **Measuring electric currents.** Laurence and others. 6d.

17718. **Electric cut-outs.** Parker and Rees. 6d.

17866. **Mantles for incandescent lighting, &c.** Bowman. 6d.

18589. **Secondary batteries.** Huber. 8d.

1889.

10102. **Electric wire, &c., conduits.** Allison (Macdonald). 8d.

10744. **Electric lamps.** De Pass (De Lodyguine). 8d.

12032. **Electric motors.** Jarman. 8d.

12378. **Electric rock drills.** Storey. 6d.

12615. **Dynamo-electric machines.** Patten. 8d.

12815. **Electro-motors.** Andersen and Girdlestone. 8d.

13841. **Telephonic, &c., apparatus.** Wheelless. 8d.

NOTES.

Telephonics.—As an illustration of the progress of the telephone in America it may be cited that the exchange of Minneapolis has now 1,700 subscribers on its list in that town.

Silver Medal.—Messrs. Davis and Sons, of Derby, have been awarded a silver medal for their "Outdoor" reflector electric light fittings at the Birmingham Electrical Exhibition.

Morocco.—The Sultan of Morocco has given his permission for the landing of a telegraphic cable, about which difficulty had arisen, and has granted a building for use as the telegraph station.

Nottingham.—At a special meeting of the Nottingham Town Council held on Monday, it was decided that application should be made on behalf of the Town Council for a provisional order for supplying electricity.

Society of Arts.—The opening address of the 136th session of the Society of Arts will be given by the Duke of Abercorn, C.B., chairman of the council, together with the presentation of prizes, on Wednesday, November 20, at 8 p.m.

French Telegraphs.—The French Postmaster-General finding that the French telegraphs are slower in speed than those of England and Germany, has commissioned M. Fribourg to study the modifications which might be made in the present system.

Ghent.—A central electric lighting station has just been established at Ghent by the Société Anonyme Belge. The system employed is the direct current with accumulators, the Tudor batteries being used. The dynamos are also on the Tudor system, working at 160 volts.

O. S. A. Address.—The presidential address to the City Guilds Old Students Association will be delivered by W. E. Sumpner, D.Sc., upon "Some Peculiarities of Alternate Currents," at the Central Institution, Exhibition-road, on Tuesday, November 19, at 8 p.m.

Madrid Tramways.—A company has been formed, with English capital, to construct a tram line in Madrid for which electricity will be used as motive power. The direct conductor system will be used probably, with overhead wires in the outskirts and conduits in the central part of the city.

Windsor.—The first annual meeting of the Berkshire County Council was held last week at Reading. A letter from the Windsor and Eton Electric Light Company, asking the consent of the Council, as the local authority, to an application to the Board of Trade for a provisional order, was referred to the General Purposes Committee.

Double Shaping Machine.—An improvement in the manufacture of shaping machines for engineers' shops has been introduced by the Britannia Company, of Colchester, and consists of an arrangement of tables and gearing by which two faces, vertical and horizontal, can be worked at the same time, and so save time and labour in manufacture.

Provisional Orders.—In view of the ensuing session of Parliament, the Board of Trade has, it is stated, already received over 300 applications for provisional orders for the electric lighting of various towns in Great Britain, the whole of which, if granted, will require the sanction of Parliament next session before they can become operative.

Leeds.—The Town Council has received from the Yorkshire House-to-House Electricity Company, Messrs. Latimer Clark, Muirhead, and Company, Limited, and the Electric Construction and Maintenance Company, Limited, notice of intention to apply for powers to come into Leeds. The Parliamentary Committee have the matter placed in their hands.

Tempered Copper.—The process of tempering copper, which has been one of the lost arts, has, it is stated, been rediscovered accidentally, and tests show the most remarkable strength and wearing qualities of copper thus treated. An establishment in Pennsylvania is manufacturing the tempered copper, and it is said to be especially valuable for the bearings and commutators of dynamo machines.

Bermondsey.—Upon the recommendation of the General Purposes Committee, the Vestry, at their last meeting, resolved to concur with the Vestry of St. Martin's-in-the-Fields, approving of the objections urged by the Paddington and Chelsea Vestries against the London County Council having absolute power over the laying of electric mains in streets under the control of the local authorities.

Wimbledon.—At the last meeting of the Local Board, a letter was read from the Electric Lighting Construction and Maintenance Company asking what the Board proposed to do in reference to the company's application to supply Wimbledon with electricity. The chairman said that, as the Board themselves proposed to carry out an installation, it followed that they must oppose the company's application, and the clerk was instructed to reply to that effect.

Levenshulme.—At the monthly meeting of the Levenshulme Local Board, on Monday, it was reported that at a special meeting of the Board, held on the 21st October, it was resolved that the Board consent to the application of the Manchester House-to-House Electricity Company to the Board of Trade for a provisional order, to be confirmed by Parliament, authorising the supply of electricity by the company within the area of the Local Board.

Bournemouth.—Consent has been accorded by the Bournemouth authorities to the application of the Anglo-American Brush Electric Corporation and the South of England House-to-House Electric Supply Company on approved conditions, one of the conditions being that no wires shall be carried above ground without special sanction in each case. The committee expressed their opinion that it was undesirable to grant exclusive power to one company.

Tramway Tenders.—The directors of the Plymouth Tramway Company are ready to receive proposals for traction by electricity or otherwise upon the new line which they are about to lay down, with estimates for the completion and equipment of the line. Applications should be made before the 5th of Dec., by letter only in first place, to the Secretary, Plymouth Tramway Company, care of Messrs. Walter Webb and Co., 28, Queen Victoria-street, London, E.C.

Door Alarm.—A novel electrical door alarm is described and illustrated in the *Scientific American* for Nov. 2, the invention of Mr. Daniel Streep, of Norristown, Pennsylvania. It is designed to ring an alarm when the door knob is turned from the outside only; when the door is opened from the inside no contact is made. The lock is as

usual, but the two knobs work independently, and the outer knob turns a switch which makes contact through a battery to an electric bell.

Keighley.—It has been decided to apply to the Board of Trade for a provisional order authorising the Corporation to supply electricity within the borough; but it is explained that this is only a measure of precaution against outside companies, and was not to be regarded as either committing the Corporation to any immediate undertaking, nor as preventing the introduction of a public convenience. The leading systems of electric lighting now on trial in this country will be carefully watched.

Welcher Accumulator.—The new form of accumulator devised by Herr Welcher, of Berlin, about which considerable excitement was excited in Berlin some little time ago, has been exhibited in that city. The accumulator appears to consist of several cells of a cylindrical form one inside the other, forming a combination of primary and secondary cells. The primary cells require charging every 800 lamp hours and the combination is supposed to give great advantages in steadiness and constancy.

Arc Lighting at Chelmsford.—A trial was given last week of the arc lamps for the public lighting of Chelmsford by Messrs. Crompton and Co. A Chelmsford paper, which notices the trial, says that the system promises to be a great success, but yet is not quite sure whether it would not have been better to have had the whole town lighted with the small incandescent lamps. There could have been a great many of them, and all the passages and angles could have been lighted in a way that cannot be done with a small number of arc lamps.

Electric Light for China.—A group of Chinese financiers in the Chinese quarter of San Francisco, recognising the scope which exists for the extensive introduction of electric lighting into the Celestial Empire, have formed, it is stated, a syndicate with a capital of a million or so sterling for this purpose. The Chinese Government have been approached with the view of obtaining important concessions, and in the meantime a specimen installation has been fitted up in Chinatown to convert the Celestials to the merits of the new illuminant.

Companies and Corporations.—A new point has been raised with reference to the municipal control of electric lighting, as whether the corporations who undertake the supply and so disinherit a local company already formed and allowed to proceed for some time, should not reimburse the shareholders for their initial expenditure. The *Financial News* thinks that if the consent of a local authority to the introduction of electricity within its area is to be indispensable, it would be just and reasonable that the company which is first in the field should be repaid the outlay which stirred the local rulers into activity for the public good.

Northfleet.—At the Northfleet Local Board on Tuesday the question of electric lighting was considered. Mr. Tolhurst thought they ought not to put anything in the way of electric lighting companies. Mr. Guard said Gravesend had just given consent to three companies who were about to apply for provisional orders. The Chairman did not think they should follow Gravesend. Mr. Tolhurst said they did not want to follow Gravesend, but neither did they want to be behind Gravesend. Mr. Topham complained that the Electric Tramway Company had injured the roads. It was decided to rescind a resolution against allowing electric lighting companies at Northfleet.

Conduits in Berlin.—A new method of arranging the leads in a distributing conduit, says a correspondent of *Industries*, is being adopted in Berlin. The leads consist of copper rods which are placed side by side in a conduit. Iron cross-pieces are arranged at certain distances apart in the trough, and they are covered with porcelain insulators for the purposes of insulation. Deep notches are made in the porcelain insulators to receive the copper leads, which are formed with transverse square recesses to fit into the notches in the insulators. The leads are fastened down by clips. This system is being adopted in connection with an extensive central station in Berlin.

Catalogue.—We have received from Messrs. John Davis and Son, of Derby, copies of two catalogues, A and B. Owing to business extensions this firm has found it necessary to extend their works, and divide them into two sections, Section A comprising mining, surveying, instruments, and miners' safety lamps; and Section B electric lighting plant, signals, and fittings. The two catalogues sent describe the manufacture in these two departments, and are fully illustrated. A special feature is made of protecting fittings for mines and outdoor work of all description, of which the firm furnishes a number of designs. These catalogues can be obtained at the firm's works at Derby, or at their London offices, 118, Newgate-street.

Interviewing.—Mr. Preece, according to an interviewer, has been interviewed with reference to the serious accident alleged to have occurred in New York owing to the breaking of an overhead lighting wire. Mr. Preece says that the details narrated in the telegram are simply impossible, because anyone with any elementary knowledge of electricity knows that wires have no power to throw men off to a distance, as alleged. Lord Crawford, chairman of the Electric Supply Corporation, has also been interviewed. He confirms Mr. Preece, and points out that, the broken wire being on the ground, the electricity discharged would go to earth and return to the dynamo. Both gentlemen utterly disbelieve, and rightly so, the sensational statements.

Barnet.—At a recent meeting of the Barnet Local Board, it was mentioned that the new Heisler machinery had arrived. A Mr. Oakley, of Salisbury-road, Barnet, has been visiting Taunton and appears to have been greatly struck with the arc lights in that town, and wrote to advise the Board to go and see the light there. He said the system was arc lighting, and the streets were literally as light as day; there was no comparison whatever between those lamps and the lamps in use at Barnet. Mr. Parsloe, amidst laughter, suggested that Mr. James, who has been so bitter against the electric light at Barnet, should be appointed a deputation to visit Taunton at his own expense and report to the Board. The subject was then allowed to drop. The new Heisler plant, which has been sent from America, is of 250 light capacity, consisting of dynamo and regulator as shown at the Paris Exhibition.

Edinburgh Electrical Exhibition.—A deputation, consisting of Sir George Chubb, and Messrs. A. R. Bennett, Faithfull, Begg, and Exton, with Prof. Beare, waited on the council of the Institution of Electrical Engineers on the 4th inst. for the purpose of inviting the Institution to hold a special meeting in Edinburgh next year, during the run of the exhibition, and to ask advice on the subject of awards and general matters connected with the undertaking. On the deputation retiring, the council considered the questions raised, and resolved that a meeting of the Institution

be held in Edinburgh next year, either shortly before or after that of the British Association. The project of a congress, which had also been suggested, did not meet with the council's approval. On the question of awards the council recommended the exhibition authorities to properly test and certify the merits of exhibits, but not to award medals.

York.—Messrs. James and Emmot have appeared before the York Streets and Buildings Committee with reference to the application of the Electric Supply Company for the consent of the Corporation to their application for a provisional order for the supply of electric lighting in the city of York. They stated that they would not apply for an order in case the Corporation themselves applied for powers. They estimated the cost of lighting for domestic purposes as equivalent to a charge of 3s. to 4s. per 1,000ft. of gas, while they would be able to undertake street lighting at a cost equivalent to 3s. 6d. per 1,000ft. of gas. Further, that they would be able to supply the light within four or five months after being enabled to proceed. The committee promised to give the application their consideration, and subsequently instructed the town clerk to report to them upon the practicability of the Corporation themselves obtaining a provisional order during the next session of Parliament.

Cardew Voltmeters.—The importance of a thoroughly trustworthy electric pressure gauge for the engine-rooms of electric light installations is always before the minds of electrical engineers, when they remember that they must place these installations in the hands of enginemen and attendants, who have to take the responsibility of its working. The Edison and Swan Company, in endeavouring to place before the market instruments of accuracy and good construction, have adopted the Cardew voltmeter to recommend to their customers, and arrangements for its manufacture have been made under license with the patentees. They now issue a price sheet of these well-known instruments of "Ediswan manufacture," and the facilities the company possess for careful manufacture, added to the delicacy of this form of voltmeter, and the fact that it is equally useful for direct or alternating current systems, should lead to considerable increase in its use in new installations.

Technics and Languages.—Sir John Coode in his address to the students at the opening of the Walker engineering laboratories, gave some excellent advice to embryo engineers with regard both to technical and to physical development. He emphasised the immense advantages which present day students possess over those who, like himself, were in training fifty years ago, and urged them to avail themselves of the advantages. He also dwelt on another and very important point in concluding, when he said: "I have dwelt mainly upon the technical aspects of engineering work; but remember that for the highest success something more than a knowledge of technicalities is essential, that the engineer's vacation brings him into contact with men and minds of other nationalities and other languages, that a knowledge of French and German will open to him invaluable sources of information, which must otherwise remain a closed book, and, not seldom, acquaintance with foreign tongues proves the 'Open sesame' to an honourable career; that in our profession, as in others, the highest distinctions are reserved for the engineer who is likewise a gentleman; and that one sure mark of the gentleman lies in the possession of a wide and liberal culture."

Stoke.—At a special meeting of the Stoke Town Council for the purpose of considering the electric lighting question, the town clerk explained that notices had been received from two electric lighting companies of their intention to apply to the Board of Trade for authority to supply electricity for lighting purposes within the borough of Stoke. He also made a statement respecting the action taken by the Stafford Town Council under similar circumstances. It was said the town possessed gas works, for which the rates were liable to the extent of £67,000, and it therefore behoved the Council to resist the efforts of outsiders to come into the borough for the purpose of depreciating that valuable property. The time was not far distant when the Council would have to invest further capital, either in extending their gas undertaking or providing the means of supplying the electric light. It would, therefore, be advisable for the Corporation to withhold their consent to the powers asked for being granted to the two companies who had given notice of their intention to apply for a provisional order empowering them to supply electricity in the borough. Subsequently a resolution was carried to apply for a provisional order themselves.

Magnetic Leakage.—The magnetic leakage of certain forms of field-magnets has been recently examined by Prof. H. S. Carhart, of Ann Arbor University, Mich. Two machines were examined, one of the Mather type of 500 watts capacity, constructed by one of the students, and the other a No. 2 Edison, capable of generating 5,000 watts, and the results are given in the following note in *Electrical World*. The leakage of the first machine was due to four steel studs, supporting brass yokes forming the journals, and four iron bolts attaching the magnet to the wood base. The result of rectifying these errors was an apparent gain of 32.6 per cent., shown by calculating the lines through the armature in the two cases, though the real gain is not, of course, so great on account of the cumulative effect of increase of lines increasing the E.M.F., which in turn increases the ampere-turns. The leakage in the Edison machine was between the poles and bedplate, which is filled in with zinc. Removing the cause by substituting a wooden base gave an increase of 6.25 per cent. This is, of course, a capacity increase, not an efficiency one, and shows that a saving can be made in the material used in building, and that the requisite field can be obtained with a smaller expenditure of electrical energy.

Walker Engineering Laboratory.—The Walker engineering laboratories, erected and fitted with money presented for the purpose by Sir Andrew Barclay, in connection with the University College, Liverpool, was opened on Saturday, November 2nd, with considerable ceremony. The laboratory consists of a handsome building designed by Mr. Waterhouse, suitably arranged for the purpose with a fine assortment of testing machines, drilling and planing machines, lathes, engines, and dynamos. The woodworking department contains ten lathes driven by a 12 h.p. gas-engine, which also drives a dynamo for electric lighting. The striking gear employed here throughout consist of the ingenious friction clutches of Mr. Edward Shaw, Bristol. The forty drawing-tables are each lighted with an electric lamp. The experimental engine, by Forrester and Co., Liverpool, can be worked in various ways—with separate or combined cylinders, with steam-jackets or without, and at various pressures of steam. It is also fitted with three different valve gears, the Stephenson, the Joy, and the Hackworth. An experimental dynamo can be driven by

this engine. The laboratory will be under the direction of Professor Hele Shaw, who has as his assistant Mr. Miller, and may be depended upon to do very good work in the training of engineering pupils in Liverpool.

Electric Light in Rome.—A contract has been signed, says the Rome correspondent of the *Standard*, between the Commune of Rome and the Anglo-Roman Gas Society for the illumination of Rome and the suburbs by electric light. One hundred and sixty-seven electric lights will take the place of 706 gas lights, at an increased expense of nearly 26,000 francs annually. The motive power will be derived from the waterfalls at Tivoli, and the station for the distribution of the power will be near Porta Pia. The contract provides that the whole of the works for the complete illumination of the city and suburbs shall be in working order in one year and eleven months from this date. Rome does not, in this case at least, lose in picturesqueness what it gains in modernisation, as the lovers of the good old times of dirt and darkness would have us believe is always the case. The few electric lights already established—as, for instance, on the Quirinal Hill and in the Piazza Colonna—lend a singularly new and beautiful aspect to the Eternal City as seen in the evening from the neighbouring hills of Frascati and the other “Castelli.” A few years hence parties may be made up to go to these places, not in the day time, but by twilight to see Rome, with its mighty overhanging Cupola, steal out into a strange silvery radiance, which across the wide Campagna is softened into something dreamlike at the touch of the electric lamplighter.

Thomson-Houston Electric Railways.—Arrangements have now been made, we are informed, by Messrs. Laing, Wharton, and Down for the energetic introduction of the Thomson-Houston system of electric traction into Great Britain, and Mr. Graff Baker, who is well known in tramway circles, has undertaken the personal management of this department. They send us at the same time an admirably got up little book, explanatory and illustrative of the system, which can hardly fail to bring conviction to the minds of directors and municipal authorities. Illustrations of systems already some years existent are given, of tracks in cities and of suburbs, over bridges and along lakes, up steep gradients, and in snow-storms. One manager mentions that during a severe snow-storm, when other horse-cars could be run with difficulty and slowly, they were able to maintain regular trips and speeds; and another (Des Moines), eulogising the financial view of the advantages, states that the company's receipts with four electric cars are “four times more than five cars with horses,” a result sufficiently remarkable. In the United States there are now over 53 roads running 349 cars on 545 miles of permanent way all fitted with the Thomson-Houston apparatus, and in addition over 25 companies with 384 cars and 441 miles of track are under contract to be so equipped, and in every case the reports from customers and owners of the lines are flattering and enthusiastic. We may perhaps hear of similar undertakings before long nearer home.

Gravesend.—At a meeting of the Gravesend Town Council on Tuesday, a discussion took place with respect to lighting the borough with electricity. The committee recommended that no consent should be given to any of the companies who had served notices of intended application for provisional orders. Councillor Butchard said the committee did not wish by any means to exclude electric lighting from the borough. As

a matter of fact, they were very anxious to get it, but at the same time they wished to have the power to make terms with a selected company for obtaining an effective light at a reasonable rate. The committee thought by withholding consent they would further that object, and when the companies applied for powers they would be able to judge of their respective merits. That was the business way of doing the thing, and no one in his private capacity would give his consent to either of these companies until he knew their respective capabilities and what their intentions were. There was no legal necessity for consent to be given before application for a provisional order. Councillor Labourn moved that consent be given to the Municipal Electric Power and Lighting Corporation, Limited, the South of England House-to-House Electricity Company, and the Electric Construction and Maintenance Company, Limited. He said the Board of Trade would see that the interests of the town were guarded before they would grant a provisional order, and it was important that there should be no delay. Margate had given its assent to the Electric Power Company, and Gravesend might safely follow suit. Councillor Cooper did not agree in giving permission to every company that liked to apply, and said it was no good for gentlemen to attend committees if the recommendations were not adopted. After some further discussion, Councillor Labourn's motion was carried.

Birmingham.—The following letter to the *Birmingham Daily Post* shows what electrical pioneers have to contend against. The writer of this letter is absolutely ignorant of the subject he treats. In America electricity-worked tramlines are going ahead with leaps and bounds, and pushing over both horse and wire-rope traction. Here is the letter: “Sir,—As a tramway shareholder will you kindly permit me, through the medium of your widely-circulated columns, to direct the attention of others so interested to a change of system that is proposed in propelling tramcars through our city? Although only one company out of three so engaged propose to make a change, no doubt the other companies will have to follow with some kind of motor in order to remove the dangerous and intolerable nuisance of locomotives traversing the streets of the city. It is proposed to resort to electricity by conveying that power to vehicles by secondary batteries loaded with electricity, which when so charged are to be placed beneath the seats occupied by the passengers in the tramcars. It need hardly be stated that the electricity in the first place is produced by means of powerful steam-engines and plant of costly character, the cost of which will devolve upon the shareholders directly or indirectly. Now, before any further capital is expended, I think the shareholders are justified in asking for some statistics or data of reliable and undoubted character that will show a substantial improvement to our dividends to justify the additional capital. I read with great interest the account of the trial trips a few days since; but it must be observed that the experiments then tried were exactly what has been done over and over again in the United States, where there are no lack of electric experts and plenty of enterprise, but where electricity had to give way to other systems more profitable and certain. With all due respect to our tramway directors, let us hope that the electric mania will not lead them from the right path. The Public Works Committee consist of gentlemen of high business character, and when once you obtain their consent to any system you may lay before them they are not likely to open their ears to any subsequent grumbling.”

Oriental Telegraph Cyphers.—It may have occurred to many people that the Chinese written language, with its vast array of ideographs, would be most unsuitable for telegraphic purposes, yet this is far from being the case. Almost the solitary advantage which their cumbersome system may be held to possess is that the true meaning of any one symbol cannot possibly be confounded with that of any other of the 120,000 words which are to be found in a Chinese dictionary. Every character is complete in itself and forms a perfect word-picture. In their telegraphic system they had recourse first of all to the engraver, who provided box-wood blocks having on one face the word-picture in relief, and on the opposite side a number corresponding to that in the catalogue which was compiled for the purpose, and which comprises all the symbols in general use, about 10,000. The numbers run from 0001 to 9,999, and when any given number is signalled in the telegram, the translating clerk at the telegraph station is able to pick out the block required from his type-case and stamp an impression of it upon the paper which is delivered to the addressee of the message. Unless, therefore, the number be wrongly signalled, there is no possibility of the sender's wishes being misinterpreted. The catalogues are purchasable by the public, and by arrangement with his distant correspondent it is competent for a merchant to compose his message of numbers, which shall be say, 10 or 100, in advance of those really intended, forming a practical cypher, which can only be understood by the initiated. Naturally, such a cypher is exceedingly valuable when telegraphing to places beyond the confines of China—the Chinese legations at foreign Courts, for example, are readily able to correspond with Peking in a code which even "barbarians" cannot comprehend. The Japanese language requires 49 combinations of dots and dashes to translate it into the Morse code, so that some additions to the original alphabet were necessary, but now they are able to correspond in their own tongue by wire with the utmost facility, the clerks being trained to signal either European telegrams in the 26 letters of the English alphabet or native messages in the 49 syllables of the Japanese language. The charges for native messages are based upon the number of signals, and a message of 20 syllables, independent of the address, is sent 100 miles for about 2d. of our money. Japan possesses a most complete network of wires, connecting every town and large village with the capital. They extend for something like 3,000 miles in all directions, and are worked with perfect regularity and at as high a rate of speed as obtains anywhere out of Great Britain. The Chinese have not reached anything like so high a standard of development, but it is something to be able to say that they have lines of telegraph there at all. The Celestial Empire makes very slow progress, but nevertheless it is sure. In the matter of cypher telegrams they can at all events claim to have a system about as complete, and yet simple, as could be devised.

Wolverhampton.—The new manufacturing works of the Electric Construction Corporation, which are about to be erected on the Gorsebrook estate, at Bushbury, will be of a most extensive character, and complete in every detail. The architect, Mr. G. H. Stanger, C.E., has also made provision for an easy extension of the workshops. Mr. Henry Lovatt, builder and contractor, of Wolverhampton, has secured the contract for building the works, the amount being £40,000, and the work is to be completed in

seven months. The total area of land to be covered with buildings is but $3\frac{1}{4}$ acres, but with macadamised yards and other details the area will be brought up to $4\frac{1}{8}$ acres. Very little of an ornamental character will be seen about the buildings, except at the front entrance to the offices and the clock tower, utility and strength having been the main considerations in devising the plans. The front elevation to the offices will be of pressed red brick, with a stone string running in a line with the window-sills, and there will be stone heads to the windows, while over the main entrance will be a clock tower. The whole of the shops and warehouses will be built of red bricks. The office for the timekeeper and weighbridge clerk is placed between the workmen's entrance and the main entrance and office, so that the timekeeper will be able to take cognisance of everyone who enters or leaves the premises. Three waiting-rooms will be provided, one which will be for the office, and one for the works, and adjoining the office set apart for the use of Mr. T. Parker. There will also be a large board-room, offices for the chief draughtsman, electrician, and secretary. A strong room will open out of the secretary's office. Near to it will be a storeroom, telephone-room, and enclosed space for a type-writing machine, adjoining the corresponding clerk's desk. In addition, a photographic room will be provided for copying drawings, and a pupil's room and clerks' dining-room. The largest drawing office will be 32ft. by 34ft. 6in., and the clerks' office is of similar dimensions. From the works a passage leads to the two last-named offices, so that enquiries may be made for plans and instructions given to workmen without the men having to enter the main office. A covered passage also leads from the office into the warehouse. Below the cloakroom will be a cellar, in which will be placed a circulating boiler for heating the whole of the offices. The warehouse will be built of blue brick, with pressed blue brick arches and pilasters, the panels being filled in with Tibbington bricks. The laboratory will be 60ft. by 20ft., divided into physical and chemical departments by a glass partition, and at the end will be a small space for the storage of batteries. The erecting-shops, foundries, and other buildings will be on a large scale, and will be fitted with travelling cranes, and the most modern labour-saving appliances of this character, and the railway will run their full extent outside, so that material may be brought and removed with the greatest despatch. The roofs of these buildings will be glazed the whole length, and the pillar supports will consist to a certain height of two columns of 6in. cast-iron pipes, the principle adopted being similar to that brought into use in the erection of the Manchester Exhibition. The blacksmiths' shop will be designed for 12 forges, but at first only seven will be placed in position, and the remainder of this department will be used as an iron store. Mess-rooms will also be provided for the men and women. The men's room will be 70ft. by 40ft. and will be capable of accommodating 225; and the women's room, capable of seating 100 at table, will be 40ft. by 30ft. Between the two rooms will be a large kitchen with larder and other conveniences. A copious supply of water will be obtained from a stream at the end of the site, whence it will be pumped into an elevated tank over the boiler-house, and thence distributed by gravitation over the works. The work of erecting the buildings will be taken in hand at once, and it is expected that in about nine months this new hive of industry will be in full operation.

THE CONVERSION OF ALTERNATING INTO DIRECT CURRENTS.

There is perhaps no other problem so tempting to the inventor than that of obtaining direct from alternating currents, for if a practical method of conversion be discovered it would at once enable us to combine storage with alternate-current distribution. One of the earliest attempts in this direction was made by Messrs. Gaulard and Gibbs, who experimented with a commutator revolved by a synchronising motor, and which was so constructed as to reverse the direction of each alternate-current wave, but the difficulty of obtaining a sparkless commutation was so great that the instrument has never been introduced into actual practice. To obtain the same effect without the use of a commutator would thus appear to be the better way of dealing with this problem, and if our esteemed contemporary, the *Electrical World*, is correctly informed, Mr. N. Tesla has actually devised a series of instruments all capable of converting alternating into direct currents—at least, on paper. We make this restriction advisedly, for the description of these instruments gives the reader the impression that they are mere suggestions, and have never been tried in practice; there is, in fact, not a word to show that any of them have been worked. On the other hand it is certain, on scientific grounds, that neither of them can possibly work. The great reputation of Mr. Tesla as an ingenious inventor, combined with the excellent character of the journal which in all seriousness puts forward his latest invention, might, however, lead many to think that notwithstanding its startling character, this invention is really good, and will work. If so, they will waste much time over a hopeless problem, and it is principally to prevent this that we propose to briefly point out in what the fallacy lies.

In all arrangements Mr. Tesla splits the alternate current into two branches, in each of which he inserts a device producing an E.M.F., or, to speak correctly, supposed to produce an E.M.F., in a given direction only. The direction in which this E.M.F. acts is such that it opposes the + waves in one branch and the - waves in the other branch. In one arrangement the device is a battery, and if the E.M.F. of each of the two batteries is equal to that of the + and - waves we shall have only + waves passing through one, and only - waves through the other branch. So far there can be no doubt that the arrangement will work, but it is equally clear that whatever electrical energy is developed in the circuit is entirely derived from the two batteries, and the amount of energy would not be altered if we disconnected the machine altogether. This, however, by the way. The other arrangement devised by Mr. Tesla cannot even work at all. Instead of a battery, he inserts into each branch circuit an induction coil with a strongly saturated core, and the connections are so made that whilst a + wave in one circuit tends to magnetise the core more strongly, the same wave in the other circuit tends to demagnetise the core of the induction coil inserted there. According to the inventor's idea, the point of saturation should be so chosen that the rate of increase of magnetisation should be small, and the rate of decrease large, both being produced by currents of the same strength. Now, it is clear that a small increase of magnetisation can only produce a small counter E.M.F., due to induction, and it is equally clear that a large decrease must produce a large E.M.F., tending to keep the current flowing in the direction corresponding with the magnetisation of the core. Therefore, argues Mr. Tesla, the induction coil with a saturated core will act as a kind of electro-magnetic clack-valve, letting more current pass in one direction than in the opposite direction, and we shall thus get through our bifurcated circuit a current which is almost continuous, and flows constantly in the same direction. This sounds very plausible, but is, nevertheless, completely wrong. The fallacy lies in this, that it is assumed that the E.M.F. produced either in one direction or the other, acts simultaneously with the current which has produced change of induction. In reality, however, the E.M.F. lags by a quarter period behind the current and induction. When the induction is a maximum or minimum there is

no E.M.F., and when the induction passes through the phase of its greatest change the E.M.F. is a maximum. By employing a saturated core in his induction coil, Mr. Tesla will succeed in distorting the curve of E.M.F., but he will not succeed in completely or partially wiping out one half of it. The induction may vary between a small positive and a large positive value without ever becoming negative, but, nevertheless, the E.M.F. created in the coil will change sign at each extreme value of induction, and have alternately a maximum positive and an equal maximum negative value each time that the induction passes through a phase about midway between its extreme values. It is astonishing that so simple a matter should have escaped the gifted inventor of the alternate-current motor, but such being the case it is likely that others might fall a victim to the same illusion, and it is with a view to warn them, and prevent their wasting time and money on an electrical chimera, that we have entered at some length into a matter which properly belongs to the ABC of alternate-current work.

NEWCASTLE.

In all probability many of our readers may have seen references to the curious deadlock which has occurred at Newcastle in relation to the electric light. The whole question is fully gone into in a special article in the *Newcastle Daily Chronicle* of the 13th inst., and which we cannot do better than reprint herewith. Many other local authorities will be glad to know the cause of the deadlock, and also the results when it is removed. The following is the article referred to:

The diffusion of power of one kind or another from central generators is a problem that has long given occupation to the minds of scientists, and its consideration is ever and again resulting in practical benefit to the consuming public. By way of a very common example, coal gas may be cited. There is not a town of any size in which this lighting power is not conveyed through pipes to the streets and houses. In some places—America and France, principally—motive power is conveyed through pipes by means of compressed air, and heating and steam power is sent in a similar way from generators in central places. Just now, attention is being chiefly devoted, in this direction, to the distribution of electricity for lighting purposes. There are many who look forward to the disappearance of gas as an illuminant of common use, and to the general adoption of electricity; and scientists are racking their brains to discover still cheaper and better methods than are at present known to generate and transmit the mysterious power. This was the subject of interesting papers and discussions at the recent meeting of the British Association in Newcastle, and a system for which the inventor claimed many advantages was explained to the Section for Mechanical Science. In the systems that have already been adopted, or that are likely in the near future to be adopted, the methods must be practically the same. There is, first, the generation of the main supply in the central station. Then the accumulation in storage stations situated at suitable distances one from another, the accumulators being charged at high pressure and discharged for distribution at low pressure automatically. From the mains, the current is led into the houses, where the installation is made by means of "transformers." There are several towns in England where the electric light is already in common use, and for an example of local enterprise in this respect one need go no farther than the neighbouring township of Cowpen, which forms part of the town of Blyth.

Most people hereabout doubtless know that in our own city powers have been acquired by two companies for the supply of electric lighting to as many people as care to pay for the convenience. These are the Newcastle and District Electric Supply Company, at Forth Banks, and the Newcastle Electric Lighting Company, near the New Bridge-street railway station. Both companies have had their premises fitted up and their plant erected, and are ready to go on at any

moment with the laying of the cables. But an unforeseen difficulty has arisen, and until that has been overcome the Board of Trade will grant neither company a license to proceed. The trouble is a peculiar one, and has come about in this way: the two companies, in the first instance, submitted their proposals to the Newcastle Corporation, who after proper consideration approved of them. The plans were then sent to the Board of Trade, which is the licensing authority, and were returned, with certain suggestions, that were approved and cheerfully adopted by the companies and by the Corporation. It was supposed that there was nothing in the way of an immediate beginning. But the town clerk, while studying the Acts of Parliament relating to electric lighting, discovered that, although there were certain penalties threatened if a company, after laying its mains, should neglect to repair the streets, yet there was no authority that had power to set the law in motion, and to initiate a prosecution. This curious predicament, which has happened before in relation to other matters, was communicated to the Board of Trade, who, finding the point puzzling to themselves, promised to submit it to the law officers of the Crown. These gentlemen were away at the time for their holidays, and the question had to be delayed until they returned. When at length the matter came to be considered, it was decided that the Electric Lighting Act made no mention of the point at all, and that it would probably be necessary to have further Parliamentary powers concerning it. Probably there was a *prima facie* supposition that the companies would offend; at any rate, the licenses are withheld until the knotty point can be satisfactorily unravelled. The delay is, naturally, exceedingly vexatious and costly to the two companies. Their plant, which represents their capital, is lying idle, and has to be maintained at considerable expense. The mains and pipes are ready for laying, and when once a beginning can be made the connection between the generators and the houses and shops where the light is required will be effected in a very short time indeed.

Yesterday, a representative of the *Chronicle* was kindly permitted to inspect the premises at Forth Banks, adjoining the works of Messrs. R. and W. Hawthorn, engineers. Everything there is now complete, and the means of supplying the electric current is of the best and most efficient kind. In a roomy building on the ground floor three large Lancashire boilers have been placed. They have been built by Messrs. Hawthorn themselves, and are the largest and best stationary boilers that the firm has turned out. Each boiler has two flues, and is 30ft. long and 7ft. 6in. in diameter. They are of steel throughout, and work at a pressure each of 140lb. to the square inch, and each boiler weighs 23 tons 9 cwt. It is believed that, in the beginning, only two of the boilers will be required to do the work, but the promoters look forward to an ever-increasing demand, and there is space enough to accommodate at least six boilers of the same size. At the back of the room there is a shaft reaching from Messrs. Hawthorn's engineering works for the supply of coals to the boiler-room. After many years, the North-Eastern Railway Company have agreed to a connection between their railway and the Forth Banks Engineering Works. A siding is now in course of construction, and when it is completed coals will be sent direct from the railway to the engine works, and dropped thence down the shaft into the boiler-room, where they will be wheeled about by means of small trams. The engine-room is above and behind the boiler-room, and is reached by means of a short flight of steps. It is a light, airy room, plainly but neatly boarded with stained and varnished panels. Here are placed the generators, in the form of combined engines and dynamos, designed and manufactured by the Hon. C. Parsons, whose patent they are. There are four such machines at present in position, but only two of these will be necessary at first. There is space, however, for five more. In the present engine-room and boiler-house there may be generated power enough to supply from 20,000 to 30,000 lights, and arrangements have been made by which the company can at any time take in the property adjoining. Above the engine-room are large tanks, whereby a regular supply of water is assured to the boilers, the object throughout having been that if any con-

tingency should arise it would not cause any delay in the supply of the lighting.

From the generators in the engine-room, wires run over the boiler-house and down into the ground, and they continue underground until they are taken into the places where the light is introduced. At regular distances there are large iron boxes, in which the current may be automatically regulated for domestic supply, and the wires may be taken out and repaired or replaced without disturbing the ground at all. This method is much more costly than conveying the current along aerial wires, but it has many and very important advantages. The public, at any rate, will be spared the fear of the danger that has always been supposed to come from overhead wires. It is only the other day that a fearful and wonderful story came from America—these stories generally do come from America—telling how a broken wire had fallen upon a horse and literally roasted it; although, to be sure, the high colouring was somewhat modified afterwards, when the impossibility of the occurrence was demonstrated, and when the narrator of the incident admitted that he had got his facts at second hand. Still, it is true that many people object to the electric light by reason of its real or supposed danger. Even leaving the outside wires out of the question, there is the possibility of severe and sometimes dangerous shocks from the use of transformers for purposes of installation; but most of these risks have already been got over, and the rest of them will doubtless in time be overcome. Besides the danger of shock, there is also the risk of fire, and it has been universally recognised that the electric light can be considered as a safe illuminant only when the strictest attention is paid to the details of an installation. In this respect the regulations that are imposed are so safeguarding that no fire of magnitude has been traced to this cause. Many ingenious devices have been applied to the prevention of leakage, and the danger has been reduced to a minimum.

The second company, the Newcastle Electric Lighting Company, has established itself at Pandon Dene, or what used to be Pandon Dene. It is not so many years ago since this was a beautiful valley with a rippling burn meandering between pleasant gardens. But the burn became a sewer, and was covered over, and the valley was filled up with countless loads of soil. This made-up land has lain till it has thoroughly settled, and here have been erected the headquarters of a company whose business it will be to spread light among the people. They have set up a spacious brick building, with boilers and engines of the newest and best description. Here, too, everything is in readiness to go on with the laying of the mains, as soon as the license comes from the Board of Trade. Once the companies have got to this work, a week or ten days will be all the time needed to supply places within a reasonable distance. The project has found considerable favour in Newcastle, especially among men of business; and each company has, we are informed, receive a large guarantee of custom. In some cases, pending the granting of the licenses, small local installations have been made, and the new illuminant is already in use. The two companies are, to a certain extent, and must continue to be, rivals in the supply of their electricity. At present, each company has the run of the whole city, but in practice this has been found to lead to awkward complications. To avoid these in Newcastle, the Corporation will probably suggest some modifications. It has, indeed, been suggested, and the proposal has several supporters, that the Corporation itself should take over both concerns, and apply the profits—for it seems to be taken as granted that there will be profits—to the reduction of the rates; just as it has been proposed that they should take over the gas and water supplies. That is a question that will doubtless be considered some day more seriously than it has been hitherto. For the present, the promoters of both companies are sanguine of financial success. There are difficulties in their way, but they are no greater than the difficulties that mechanical and scientific ingenuity has already overcome. It is anticipated that, once a beginning has been made with the installations, there will be a growing demand for the new light, and the promoters heartily endorse the assertion made at the meeting of the

British Association in Newcastle by an eminent electric lighting authority, that "the apostles of electricity believe that they will and must succeed in the end." They believe that there are among us some who are yet so young that they will live to see the day when gas—whether coal gas, or water gas, or petroleum gas—will be considered as antiquated as we of the present generation regard the farthing dips of a by-gone day; when this mysterious force of nature, which is ever finding vent in new and astonishing directions, will contribute to our comfort and convenience in numberless ways, sending the older and weaker agencies to the wall. Who knows?

NEW YORK NOTES.

(FROM OUR SPECIAL CORRESPONDENT.)

*Conclusion of the Feeks Inquest—Mr. Gibbens's Eloquence.
A Sensible Verdict.*

*A "Facer" for the Board of Electrical Control.
The Wires are to Stay Up.*

Judge Andrews Continues the Injunctions.

Views of the National Electric Light Association.

The Edison Company's Endeavours to Profit by the Crisis.

Mr. Edison on "The Dangers of Electric Lighting."

Dr. Norvin Green on Telegraph Rates.—Some Curious Statements.

The Fourth-avenue Electric Cars Laid Up.

The Postmaster-General's Back Down.

NEW YORK, November 2, 1889.

The Feeks inquest was concluded this week, the jury having been unable, in spite of the prolonged investigations, to fix the responsibility for the accident on any one company. One of the last witnesses examined was Mr. Gibbens, the most youthful and obstructive of the three commissioners who compose the Board of Electrical Control. Mr. Gibbens's evidence consisted of the reading of a long statement in defence of the Board and the Subway Company, and violently attacking the electric light companies. In their verdict the coroner's jury decided that Feeks's death was caused by an electric shock received either from a Western Union telegraph or Metropolitan telephone wire, which they believe to have been in contact with an electric light wire, belonging probably to either the Brush or the United States Illuminating Company. The verdict goes on to say that the accident was due to the dangerous condition and lack of proper insulation of the overhead electric wires in the city; the use of "underwriter's" wire is condemned; recommendations are made that the subways be extended with all possible despatch until all wires are placed underground, and that meantime wires carrying high-tension currents should not be placed on the same poles with telegraph and telephone wires. It is also recommended that all linemen be "imperatively required" to use rubber gloves and insulated tools while working on the lines, and that a licensing board should be appointed which shall grant permits only to men who have passed an examination proving themselves competent to intelligently perform the hazardous duties of linemen. The concluding paragraph of the verdict contains some wholesome and much-needed advice for the Board of Electrical Control. It runs as follows: "We are convinced that the present antagonism between the Board of Electrical Control and the corporations supplying electricity is such as to prevent the safe conduct of electrical business in this city, and we recommend, on the one hand, that these corporations exercise more readiness to obey the reasonable regulations of the Board, and that, on the other hand, the Board enforce its rules with greater regard for the vast amount of capital invested, and with a particular view of providing for the public the very best service." No disrespect to the poor fellow's memory is intended, but one cannot help breathing a sigh of relief as he says "and that's the last of Feeks."

It will be acknowledged by all sensible electricians that the jury have done their work uncommonly well, and it is especially pleasing to observe that they have neither been influenced by the extravagant rhodomontade of Mr. Gibbens in defence of the corrupt hotbed of jobbery of which he is a member, nor by the prejudiced and alarmist views of Mr.

Edison, to which so much prominence has been given by some of the sensational dailies. The jury hit the nail on the head in finding the cause of the accident in bad construction and poor insulation, and the crowding of electric light wires on the same poles with telegraph and telephone wires. The root of the whole evil which has brought on the present crisis in electric lighting affairs is to be found in the eminently "cheap and nasty" work which is the principal feature of outside electric lighting construction in New York.

After taking 10 days for consideration, Judge Andrews, of the Supreme Court, has decided to uphold the injunctions granted to the electric light companies restraining the Board of Electrical Control from summarily removing the wires without giving the companies a chance to repair them or until the subways are provided. The gist of the decision is that the Board has exceeded its powers, both in its resolutions and in its threats; some of the wires are, no doubt, in bad condition, and should be repaired or removed. The Board has the right to require the companies to discontinue to use the wires while they are in bad condition, but not to order their removal without giving the companies a reasonable opportunity to make repairs. Judge Andrews continues the injunction upon the condition that the electric light companies interested will stipulate to take short notice of trial for the November term, and will try their case at the first opportunity.

While on the subject of the wires, it is well to mention that the National Electric Light Association held a meeting at the Electric Club last week for the purpose of discussing the overhead wire question. The meeting adopted a series of resolutions, to the effect that the high-tension currents now in use are absolutely necessary for the successful and economical working of light and power plants, and to substantially reduce the pressure would so increase the cost of electric light and power as to put them out of reach of many consumers, and greatly cripple the electric light and power industries; that the recent accidents have been due to faulty construction and defective insulation, coupled with restrictive legislation and divided responsibility, which for years have prevented such comprehensive repairs and reconstruction as would have ensured safety and good service; that the progress in the art of insulation has been such that overhead wires carrying direct and alternating currents of the intensity now in use can be so insulated as to be safe. The resolutions, further, go on to say: "We deprecate the effort on the part of certain electric lighting interests who have committed themselves to the use of low-tension currents, so to direct the present public discussion as to bring the high-tension alternating and direct currents into disfavour, in the hope of benefitting themselves and injuring their rivals." This refers to the Edison Company, which has been working might and main (or perhaps it would be more appropriate to say mains and feeders) to turn the situation to its own advantage. Mr. Edison has made many wild statements to newspaper reporters, and these statements, duly embellished, have been given great prominence, and, no doubt, owing to the glamour which surrounds the name of Edison, they carry weight with the uninitiated. The Edison Company have a "card to the public" in the principal dailies proclaiming the harmlessness of the Edison system and inviting inspection of the apparatus at their up-town central station, where at certain hours of the day an employé will be in attendance to administer invigorating shocks of 115 or (on the three-wire system) 230 volts, free, gratis, and for nothing.

In addition to all this, the current number of the *North American Review* contains a colossal free advertisement for the Edison Company in the shape of an article by Mr. Edison on "The Dangers of Electric Lighting." The article is directed against the use of high-tension alternating currents, and the following are a few extracts: "There is no plea which will justify the use of high tension and alternating currents, either in a scientific or a commercial sense. They are employed solely to reduce investments in copper wire and real estate." "My personal desire would be to prohibit entirely the use of alternating currents. They are as unnecessary as they are dangerous." "I have always consistently opposed high tension and alternating systems

of electric lighting (although perfectly free to use them), not only on account of danger, but because of their general unreliability and unsuitability for any general system of distribution." What would Mr. Ferranti say to that? In view of all that he has said and all that he has written about the fearful dangers attending the use of high-tension alternating currents, perhaps the most ingenuous sentence of Mr. Edison's article in the *North American Review* is that in which he says "I am not, and I am sure none will accuse me of being, an alarmist."

The same issue of the *North American Review* also contains an advertisement of Mr. Harold P. Brown in the shape of an article by that eminent "electrical expert" on "The New Instrument of Execution," and an article by Dr. Norvin Green, entitled "Are Telegraph Rates too High?" Dr. Green thinks they are not, and as he shows that the operating expenses amount to more than 75 per cent. of the rates charged to the public he seems to have made out a fair case. One or two of Dr. Green's statements in that portion of his article devoted to a "comparison with other countries" are rather curious. It will certainly be news to your readers that only "a few of the longer submarine cables are owned and controlled by private corporations." Speaking of European Government systems, Dr. Green says: "With rare exceptions their telegraph service is provokingly unsatisfactory. Even between two such prominent commercial centres as London and Paris the service is so unreliable in point of time that some large commercial houses, when they want their messages to go promptly, send from London to Paris by way of New York over the transatlantic cables."

The Fourth-avenue electric cars, which have become so popular with the travelling public, have been temporarily withdrawn, as the Accumulator Company have obtained an injunction against the Julien Electric Company, on the ground that the Julien system is an infringement of the Faure patents, which are worked by the Accumulator Company. It is said that the cars will be running again shortly, as alterations are being made in the plant to allow of the active material being applied to the plates in the form of a powder. The action for infringement of the Faure patents lay in the employment of a paste.

The Postmaster-General has made a complete backdown in regard to the proposed mill-a-word rate for Government telegrams. He has now fixed the rates at 10 cents for ten words (exclusive of address and signature), and half a cent for each additional word for distances not exceeding 400 miles. Between 400 and 1,000 miles 15 cents for first 10 words and three-quarters of a cent. for each word beyond, and for distances exceeding 1,000 miles half a cent. per word more than the previous rate. For night messages the rate is to be 15 cents for 20 words (text) and half a cent. for each additional word for all distances. In a letter to Dr. Norvin Green, the Postmaster-General says that he is convinced that the Government is entitled to very special consideration in rates and privileges of telegraphic service, and proposes the appointment of a commission of five suitable persons (two by the Western Union Company, two by the Postmaster-General, and the fifth by the four so chosen) to enquire and report upon the actual cost and proper value of telegraphic service, and recommend equitable rates for Government work.

EDINBURGH ELECTRICAL EXHIBITION.

On Monday a special meeting of the Electrical Trades' Section of the London Chamber of Commerce was held at the offices, Botolph House, Eastcheap, Mr. R. E. CROMPTON in the chair, to receive the report of the committee appointed at the meeting on the 28th ult. to consider the conditions on which it might be advisable to take part in the exhibition.

Mr. A. P. TROTTER (the sectional correspondent) read the report, in which the committee stated that, if the exhibition committee in Edinburgh had consulted the electrical trades as to the desirability of holding an electrical exhibition in the year 1890, they would probably have received a well-nigh unanimous answer that it was too soon after the Paris Exhibition to serve any useful trade purpose.

The exhibition authorities must pay in the usual manner for the lighting of the exhibition. The charge for space should be 2s. 6d. per square foot, the minimum charge being £2. 10s. The committee thought that the electrical exhibitors should be allowed an agreed-upon space free, and should pay for any additional space they might require. They thought that when steam power or current was necessary for the proper display of an exhibit they should be provided free of cost by the exhibition authorities, who ought also to pay for the insurance of the electrical exhibits. The committee suggested that there should not be any awards; but if it was determined to have awards they thought that the council of the Institute of Electrical Engineers and the electrical section of the London Chamber of Commerce should recommend the jurymen to the exhibition authorities. Clause 25 of the regulations was as follows: "The executive council reserve to themselves the right of examining, testing, or analysing any of the exhibits." The committee did not think that any person outside the electrical jury should have the right to test, analyse, or examine any of the electrical exhibits, and they thought that any electrical exhibit might be sent without being in competition, and that such exhibits should not be tested or analysed even by the jury. They had good reason to believe that well-nigh the entire trade would support the improved and reasonable conditions suggested.

On the motion of Major FLOOD PAGE, seconded by Mr. A. LE NEVE FOSTER, a resolution was passed adopting the report and referring the subject to the permanent committee of the section, with power to negotiate and carry out the necessary arrangements with the exhibition committee.

Mr. Lee Bapty and Mr. Gaskell Exton, who attended to see the sectional committee on the subject of the proposed exhibition, were then invited into the meeting, and

The CHAIRMAN explained to the former gentleman the chief points recommended in the report.

Mr. BAPTY, in reply, stated that he had only been appointed general manager of the exhibition after it had been decided on generally. All that the promoters of the exhibition desired was to present to the visitors the latest developments of electrical science and industry; and after the legal demands were met any money paid for space by the electrical exhibitors would be returned in full, or as near as the surplus would allow. He would be prepared to ask the exhibition committee to meet the trade on the point of paying the insurance. With reference to the question of awards he thought he might say that the exhibition authorities would leave themselves in the hands of the representatives of the trade. The right which the executive council had reserved of testing any of the exhibits was not intended to apply to machinery or electrical apparatus, but to any intended exhibit which might be dangerous; and he would advise the council not to put the rule in force as regarded the electrical section of the exhibition. The exhibition authorities had never intended to ask for the lighting to be free. In regard to electric lighting, it would form a separate item. He thought there ought to be no difficulty in providing free current. With the support of the trade no effort would be wanting on the part of the executive council to make the exhibition a great success.

Major FLOOD PAGE thought they should be much encouraged by what had fallen from Mr. Lee Bapty, who was afterwards asked to arrange that the closing time for electrical entries should be extended from the 1st prox. to January 1 next.

Royal Meteorological Society.—At the meeting of the society, to be held at 25, Great George-street, Westminster, on Wednesday, the 20th instant, at 7 p.m., the following papers on electrical subjects will be read: "Second Report of the Thunderstorm Committee—Distribution of Thunderstorms over England and Wales, 1871-1887," by William Marriot, F.R.M.S.; "On the change of Temperature which accompanies Thunderstorms in Southern England," by G. M. Whipple, B.Sc., F.R.M.S.; and "Note on the appearance of St. Elmo's Fire at Walton-on-the-Naze, September 3rd, 1889," by W. H. Dines, B.A., F.R.M.S.

THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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Specimen copies of the paper will be sent on request.

EDINBURGH EXHIBITION.

Comparatively few members of the London Chamber of Commerce have troubled to attend the meeting of the electrical section to consider the conditions on which it might be advisable to take part in this exhibition. This laxity may easily be accounted for. The exhibition has been decided on, and will be held whether or no. Collective action from the trades interested may be preferable, but under any circumstances isolated exhibits would be sent. Of one thing we may be quite sure, that is, that all Scotch firms will support the exhibition. However carefully a Scotchman considers the question of exhibiting abroad, his purse-strings often relax when auld lang syne is in question, and if it can be shown that firms north of the Tweed may have the opportunity of pushing their wares among those who will always accept an excuse for visiting Edinburgh, they will be there to the last unit. It will not need much of an excuse for thousands to go north. Edinburgh itself is attraction enough. Two sights of a lifetime are a view of Princes-street and a view from Calton Hill. Then there is the Forth Bridge—the wonder of the world, beating the Eiffel Tower in every way it can be looked at. But what has that to do with the exhibition and with the action of the London Chamber of Commerce? It may be that Æsop sometimes wrote his fable to produce a moral, and sometimes found a moral which necessitated a fable. Whether we have found a moral or a fable, or whether hard business facts may thus be lightly designated, is a question for solution. At any rate the exhibitor at an exhibition wants to make it pay, and to do this his first object is to ascertain if there will be plenty of sightseers. Among the sightseers he hopes to do business, and the more there are the greater is the volume of business likely to be. An important question, then, is the one we have stated, whether Edinburgh is a place likely to attract sightseers. We think it is, and that the exhibition, as we put it, will be made an excuse to visit the Scottish metropolis by thousands who otherwise would not go there. For the time of the exhibition the space occupied by an exhibit is part and parcel of the manufacturer's works or showroom. Here among the throng likely customers do come, and a percentage of business also comes from enquirers. It may be that an exhibition showroom is more costly than an ordinary showroom or advertising; on the other hand, however, it must be remembered there are exhibitions and exhibitions—the one may be a success, the other is doomed beforehand to be a failure. The probabilities must be considered and conclusions adopted. This, then, is our fable and moral, which may be repeated thus: Edinburgh is an exceedingly likely place to attract a large concourse of people; business men who exhibit want to see visitors, and from

among them to obtain customers. The time has gone past when the terms philanthropy and patriotism acted as charms, and now, unless commercial requirements are met, exhibitors are chary of incurring the enormous expenses which arise in sending goods and maintaining staffs at exhibitions.

We take it that from the electrical point of view the argument holds good. There will be nothing new to astonish the world with at Edinburgh so far as regards electric lighting or transmission of power. The glamour of the unknown may be as strong as ever with the unread, but the users of applied electricity are generally a hard-headed race, who think far more of the bawbees than of the wonderful. How much? has to be answered, and comparisons made, which, if not favourable, condemn the new aspirant. By this time reliable facts and figures are forthcoming. Installations have been running for years, and prove that, with a moderate amount of care, they can be trusted to work with regularity and satisfaction. These things, then, telling in favour of the electrical industries, it should not be difficult to decide whether to go to Edinburgh, or whether to stop away. Suggestions made later on will be less valuable than those made now, that is presuming they have any value at all. Would it be possible for those who exhibit to consider the varied circumstances under which electric lighting is used; for example, in public halls, in private houses, in ships, in mines, in factories, etc., and to make a practical exhibit showing exactly how they would carry out the work. Thus one firm with a partiality for lighting private houses might fit up one or two rooms; another, whose object was to obtain ship lighting, might fit up a saloon and cabins; a third might diversify the proceedings by extemporising a factory with the mill girls at work and the machines lighted by incandescents, or the warehouses by arc lamps. If this was not possible two firms might combine. An upholsterer might show the furniture, and the electrician light up the room, the manufacturers show the machinery, the electrician light it, and so on. Something different to the indiscriminate fixing of lamps in a given space is required. One firm may have ten thousand candle-power radiating through a given space, while a second firm has only a thousand candle-power radiating over a similar space. The comparisons made in this case would certainly be odious, and most likely altogether wrong. Actual examples being given, it would be easy to say the fittings for that room cost so much. The visitor would judge for himself as to their suitability. Alternative designs could be shown and prices given. Probably a visitor would think to himself, "I have a room or rooms somewhat about this size, and can now see approximately how they would look so lighted, and

find out the cost"; so, again, in the case of factories, wherein each machine requires a sufficiency of light, no more and no less.

One other question we should like to mention. The exhibitors are like a covey of partridges, to be shot at by all comers—in other words, to pay everywhere. An exhibition certainly is never organised for their benefit, yet they have to pay for space, besides paying for attendants. The payment for space is an imposition that should be abolished. Take this particular exhibition at Edinburgh. If it is a success, the good folks at Edinburgh will be the greatest gainers; if it is a loss, they will suffer little pecuniarily in comparison with the exhibitors. Again, the exhibition may itself be a great success, and the exhibitors be great losers—in other words, few among the visitors may be buyers. Space should at all exhibitions be provided free of cost, and allotted according to the merits of the exhibit. Intending exhibitors would then, instead of applying for space without describing their proposed exhibit, have to fully describe the exhibit and point out its merits in order to get space. A radical departure, perhaps, but one urgently needed, for now we frequently see great spaces filled with things of little interest to visitors, while other and more interesting exhibits are crowded and partially hidden from view.

CALORIC AND DYNAMIC INVESTIGATIONS AT THE CENTRAL ELECTRIC STATION OF THE IMPERIAL CONTINENTAL GAS ASSOCIATION AT VIENNA.*

BY INSPECTOR A. EHRENDORFER AND T. W. MELHUISE, A.M.I.C.E.

These trials were made to test the efficiency of the boilers and engines working the dynamos at the central electric station in Vienna. The installation consists of eight Babcock and Wilcox boilers, and 17 compound Willans engines, driving directly an equal number of Crompton dynamos. Of these, three develop each 100,000 watts, five 72,000, and the four smallest 8,000. All the boilers are intended to work at a pressure of 10 atmospheres (147lb. per square inch), and each has 63 water-tubes, each 4.72in. in diameter, and 17ft. 9.94in. long. The larger engines have cylinders of 13in. and 20in. diameter, with a stroke of 9in.; in the smaller engines the diameters are 11in. and 18in., and the stroke 9in. The trials were carried out with two of the boilers supplying steam to two of the larger engines with dynamos. A third boiler, entirely disconnected with the others, was used to work the Worthington steam feed-pumps. The fuel employed was gas coke, from the Vienna Gas Works, which, for the trial, was accurately weighed in sacks. Before starting, the quantity of cooling water under the grate—a special feature in the Babcock and Wilcox boilers—was measured. The feed-water was measured by observing the level of the water in the reservoir before and after the experiments; and, besides this, the level was noted every half-hour during the trial by means of an indicator in connection with a float. Every half-hour were observed the temperature of the feed-water, the boiler pressure, and the moisture in the air of the boiler-house, and every ten minutes the temperature of the fire-gases in the flue behind the boiler. Nine samples of the fire-gases were taken during the experiments, and analysed in Schwachhöfer's apparatus, and the cinders and ashes were carefully weighed.

* From the *Proceedings* of the Institution of Civil Engineers.

The water-level in the boiler and condition of the fire at the conclusion of the trial were, as nearly as possible, the same as at the commencement.

The following are the leading data and results :

Duration of trial	6 hours.
Total heating surface of two boilers	2820.24 square feet.
" grate area	63.29 "
Ratio of grate area to heating surface	1 : 44.5
Coke per hour and square foot of grate area ..	14.832 lb.
" " heating surface	0.323 "
Water evaporated per pound of coke	10.05 "
Mean effective boiler pressure, lbs. per square inch	143.3 "
Temperature of steam, deg. Fahrenheit	362.3
Mean temperature of feed water	185.0
Caloric value of 1 lb. of coke	13,186.98 B.T.U.
Percentage of ashes and cinder	8.2
Air supplied per pound of coke	22.39 lb.
Mean temperature of escaping fire-gases, deg. Fah. ..	527.0
" " of air supplied to grate	82.8
Percentage of heat usefully employed	79.21
Heat carried off by fire-gases	15.47 per cent.
" lost by imperfect combustion	0.88 "
" " by conduction and radiation (difference)	4.44 "
Heat communicated to water	79.21 "
	100.00
Indicated horse-power of both engines	314.43
Feed-water per indicated horse-power per hour ..	29.99 lb.
Electrical horse-power	244.76
Ratio of electrical to indicated horse-power	77.59 per cent.

The original is accompanied by diagrams showing the variations in the quantities observed during the trials.

THE LIGHTING OF THE CENTENNIAL INTERNATIONAL EXHIBITION, MELBOURNE, 1888 AND 1889.*

BY K. L. MURRAY, C.E., TELEGRAPH ENGINEER TO THE VICTORIAN RAILWAYS, MEMBER.

In November, 1887, the Executive Commissioners of the Centennial International Exhibition, which it had been decided to hold in Melbourne in the following year, consulted me as to the practicability, electrically and commercially, of using electricity as a means of lighting the exhibition, and I felt that I could assure them that the electric light was the only one which could be depended on to efficiently illuminate the buildings and exhibits, and that its cost would not render its use prohibitive.

I recommended dividing the buildings into three sections, and calling for separate tenders for supplying and maintaining the dynamo machines and lamps necessary to light each part, tenderers being requested also to submit an alternative offer for the whole lighting required. My desire was to have each section lighted by a different system, if possible. Finally, I was entrusted with the duty of drawing up a specification, and tenders were invited.

Those received all named such a high price for the work that I could not recommend the acceptance of any; but being requested by the Exhibition Commissioners to arrange with one or more of the firms which tendered, I was able eventually to do so, and a contract was entered into with the Australasian Electric Light, Power, and Storage Company for the lighting of the greater portion of the exhibition buildings; and an agreement was made with Messrs. Ganz and Co. to supply a transformer plant and light the Armament Court, the official reception and dining-rooms, and offices.

The Australian Company's contract was to supply, fit up, and maintain 825 Brush arc lamps, 37 Brush arc dynamos, seven Brush Victoria dynamos, compound wound, and 2,000 incandescent lamps, with all requisite switches and fittings. The whole of the machinery and other apparatus was to be of the latest pattern and best workmanship.

As usual in such cases, the buildings were ultimately extended considerably beyond the limits originally laid down. The lighting plant had, of course, to be increased proportionately, so that the apparatus actually supplied by

* Paper read before the Institution of Electrical Engineers on Thursday, November 14.

the Australasian Company consisted of as under: 40 Brush arc dynamos, known as No. 7/, each capable of giving a current of 10 amperes to from 23 to 25 arc lamps in series; one Brush arc dynamo, known as No. 8/, professedly capable of giving current to 55 arc lamps in series; one Brush arc dynamo with cast-iron armature, known as No. 6, supplying current of 20 amperes, for five arc lamps; seven Brush Victoria dynamos for incandescence lighting, compound wound for 110 volts at terminals; 937 16-hour round type Brush arc lamps, with alabastine globes; five Brockie-Pell 20-ampere arc lamps for lighting the dome; two Castle arc lamps; 1,900 Swan lamps of 16 c.p. at 100 volts; 27 "Sunbeam" lamps, of sizes ranging from 200 to 600 c.p. each at 100 volts; all necessary switches, fuses, and leads, the total length of the latter being over 60 miles.

The 7/ Brush arc dynamos were of two patterns. 1st, that in which the bedplate and field-magnet yokes are cast in one piece; the field-magnet cores, with pole-pieces, being, as usual in this form of machine, of cast iron, fastened to the yokes with bolts. The commutator brushes and terminals are mounted on a slab of slate, which is fitted into a recess left for it in the bedplate casting. The other pattern of arc machine has what may be termed a composite bedplate, or no bedplate at all. In these machines the two field-magnet yokes are cast in separate pieces, the cores, with pole-pieces, being, as in the former pattern of machine, bolted to the yokes. The two horseshoe magnets thus formed are connected by two pieces of railway iron, which constitute whatever of bedplate the machines have. The commutator brushes and terminals are mounted on a slab of wood fitted between the longitudinal pieces of railway iron. The first class of machine will hereinafter be called "solid-frame," the latter "rail-pattern" machines.

The majority of the solid-frame machines had previously been used at the Adelaide Exhibition, but were fitted with new laminated armatures for use in Melbourne. The balance were sent out direct from England. The frame-work of the 8/ dynamo was imported, but the laminated armature was made, and all coils were wound in, the Australasian Electric Company's workshops, Melbourne. This dynamo was of the solid-frame type. The No. 6 dynamo was also of the solid-frame type, but had a cast-iron armature. Its coils were arranged for a current of 20 amperes.

Two types of laminated armature were supplied with the No. 7/ dynamos—one having plates .05 of an inch in thickness, the plates of the other being only .022 of an inch thick. The former I will call thick, and the latter thin plate armatures.

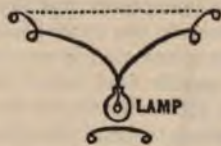
The dynamos for incandescence lighting, seven in number, were of the Brush Victoria pattern known as No. E2. The nominal output is stated to be 366 64-watt lamps at an average armature speed of 720 revolutions per minute. The machines were of the newest type, and had very massive magnetic circuits throughout. The armatures are wound with only three layers of rectangular wire, each section consisting of three convolutions. The laminated iron core in the V spaces between the windings is not covered with insulation, so that in these parts it is directly exposed to the cooling influence of the air.

The arc lamps were of the well-known Brush 16-hour round type, wound with the low-resistance shunt recently adopted by the makers. Alabastine globes were used.

In the main annexes the arc lamps were arranged in a double row down each bay, one lamp being allowed for about every 1,200 square feet of floor space. The bays were about 50 ft. wide, and the distance between the two rows of lamps was about 25 ft., the height of the globe from the floor being about 22 ft.

Incandescent lamps of 16 c.p. at 100 volts, to the number of about 1,900, were used for illuminating the picture galleries, beneath the galleries, in the aquarium, and in the cellars. The concert hall was lighted by 25 "Sunbeam" lamps of from 200 to 600 nominal candle-power. The incandescent lamps in the picture galleries were set in a single row, 9 in. apart, on reflecting frames, the reflecting surfaces of which were painted a dead white. These frames were about 18 in. wide, made of sheet metal, with a cross section as shown. Below the lamp another reflector was placed, the primary object of which was to

shade the eye from the direct glare of the lamps and keep the floor comparatively dark. With the above arrangement of reflecting frames the walls were the only portions



of the galleries illuminated by the direct light from the lamps, and the total absence of glare allowed of a very pleasant rest for the eyes.

The switchboard for the arc circuits consisted of two parallel rails of wood, on which ordinary double brass binding screw terminals were fixed. The screws on the lower rail were connected to the dynamo terminals, while those on the upper rail formed the terminals of the various lamp circuits. The positive terminals of all machines and circuits were at one end of their respective rails, and the negative terminals at the other. The connection between the dynamo and circuit terminals was effected by means of short lengths of well-insulated cable.

The incandescence switchboard was mounted on a well-finished cedar stand. It consisted of two large slabs of black enamelled slate, on which the nickelled switches and terminals were fastened. Between the two slabs of slate a suitable recess was formed in the woodwork for the reception of a Cardew voltmeter (Goolden and Trotter's make). In the centre of a cedar panel below the voltmeter a small switch was placed, by which any one of the machines could be connected to the voltmeter by turning a handle. Suitable terminals were provided for the introduction of safety fuses, and also for enabling the machines to be coupled in parallel. When so coupled, any one or more machines or circuits could be switched on or off without affecting the rest.

The arc circuits mainly consisted of 7/16s stranded cable nigrite and tape insulated, all other being of the same size of cable, but insulated with rubber and braided.

The leads were so arranged that between every two lamps getting current from the same dynamo, there were at least two lamps getting their current from some other dynamo; my object being to make certain that the building should be fairly well lighted, even if several dynamos broke down at the same time. All leads and returns ran in one direction from the dynamo-room to the main buildings. But on entering these buildings the leads and returns were taken in totally different directions to the terminal lamps of their respective circuits. By this means, and careful attention to the arrangement of the circuits, the leads and returns never approached each other, except in the dynamo-room. Consequently, short-circuiting in the buildings was almost impossible. The lamp circuits were run on the woodwork which carried the roof. The lamps were suspended by cords so that they could be lowered for carboning or other purposes. The wires from the lamp terminals were taken up the suspending cord and lashed to it at a point a few inches from the pulley when the lamp was at its proper height. They were then taken to the woodwork and fastened to it at such a height that the length of wire forming the cord, together with that from the point of lashing to the suspending rope, was at least equal to the height above the floor at which the wires were fastened. This method permitted the lamps to be lowered to the floor, and at the same time left no cable hanging in festoons about the building when the lamps were in their lighting position. From the terminal lamp of each circuit the wires were taken down the wooden pillars which supported the roof, through the floor, and (bracketed to the flooring joists) to the dynamo-room.

The incandescence circuits were arranged for a loss of potential of 10 volts. The installation was looked upon as being of a temporary character, consequently the electrical loss was considered to be of less moment than incurring a larger first outlay for heavier leads. Even with the above-named loss the leads for a portion of the distance consisted of two cables, each containing 37/14s; and for the remainder of the distance to the point of distribution one cable of the same size was used. The distribution was effected by

means of 7/16s cable, and finally by single wire. All cables were insulated to 150 megohms per mile.

The steam was generated in 12 multitubular boilers, the pressure being maintained at 120lb. per square inch.

Three pairs of high-pressure engines were used, having cylinders 20in. in diameter, with a 40in. stroke. Normal speed, 80 revolutions per minute; and the total indicated horse-power with full working load was about 1,580. These engines were made in Melbourne, and were similar to those used for working the cable street tramways. I may say here that, recognising the very great importance of having the very best driving machinery, I urged the Exhibition Commissioners to send to England for engines specially constructed for electric light work. It was found, however, that time would not permit of this, and an order was given to a firm of local manufacturers who had engines partly made, and could guarantee, therefore, to have them ready in time. The countershaft was in one continuous line, and measured 202ft. 6in. over all. It was driven by ropes from the engine flywheels, in the face of each of which 13 grooves were formed for the reception of the ropes. The shaft was in three equal sections, one for each pair of engines. These sections were connected by movable clutches, so that they could run either separately or together as required. To reduce to the lowest degree possible the inconvenience which would result if a pair of engines broke down, the dynamos driven by each section supplied current to lamps distributed over the whole buildings; so that if one-third of the light was taken off, no part of the exhibition would be left in darkness.

The main body of the shaft was 6½in. in diameter, but the size was increased to 7½in. where the three rope drums were fitted. The normal speed of the countershaft was 190 revolutions per minute.

The dynamos were arranged in a double row on each side of the countershaft, the distances between the centre of the countershaft and spindles of dynamos being 28ft. and 33ft. respectively.

At one end of the countershaft an automatic speed-recorder was placed. This recorder was essentially a chronograph, and consisted of a drum on which a sheet of paper could be fastened. The drum was driven by a tangent screw working in a worm wheel, which latter could be made fast to or released from the drum spindle by means of a friction clutch. The tangent screw was connected by a flexible coupling to the end of the countershaft. A small table was arranged, having a motion parallel to the drum axis. On the table an electromagnet was fixed, the movable armature of which carried a small glass pen. The electromagnet was put in circuit with a battery and clock, having a minute contact. As the drum was mechanically driven (without slip) from the countershaft, its circumferential velocity was proportional to the speed of the shaft; and as the clock marked equal intervals of time on the paper, the distances between these marks gave the number of revolutions of the countershaft when measured on a suitable scale. The dimensions were adjusted so that the drum made one complete revolution in five minutes when the countershaft was running at the normal speed. Hence, if the speed was normal, and without variation, the marks made by the clock would be in a straight line across the paper. If the speed did not vary, but was either greater or less than the normal, the clock marks would still be in straight lines, though making different angles with the edge of the sheet of paper. An irregular speed would show an irregular line.

Geared from the same spindle that drove the reading drum, and mounted on the same base, was a small centrifugal governor. The opening or closing of the balls brought a small contact lever against either one or the other of two contact stops. Two incandescent lamps, one plain, the other coloured red, were hung over the engines, the position of the contact lever determining which, if either, of the lamps should be alight. At the normal speed neither would show light, but a variation of about half per cent. on either side would place one or other of the lamps in circuit. The majority of the diagrams taken by the recorder showed a gradual increase in the speed of the countershaft as the evening advanced. This fact will be referred to later on.

Generally speaking, the lighting throughout the term of the exhibition was satisfactory. On three or four occasions only did anything occur which would lead the public to suspect that matters were not exactly as they should be. This comparative freedom from inconvenience through irregularities in the lighting was the result of the arrangement of the circuits, rather than the constancy of supply to any one circuit.

The boilers, which were designed by a Victorian railway engineer, and built in Melbourne, behaved admirably, though working considerably beyond their proper capacity. The steam pressure was kept extremely regular, the maximum variation seldom exceeding two pounds per square inch for the whole evening's run. The fuel was coke, with a little coal added at times when difficulty was experienced in maintaining the full working pressure required.

Notwithstanding the very regular steam pressure, the speed of the engines varied considerably, even though they were fitted with mechanism outwardly resembling Hartnell's automatic expansion gear. With the full load on the countershaft, and the engines indicating about 1,500 h.p., a single dynamo thrown off or on produced a very sensible alteration in the speed of the rest of the machinery—sufficient, indeed, to necessitate the adjustment of the rheostat controlling the potential difference at the incandescence mains, and to show itself at the speed-indicating lamps.

One evening some trials were made to ascertain the effect of an alteration in the steam pressure on the speed of the engines. For this purpose the pressure was altered one or two pounds every half-hour; and it was found that a variation in pressure of one pound per square inch produced an alteration in the speed of the engines of about a revolution per minute, all other conditions remaining the same. The cause of trouble was clearly enough in the governor, and I experienced a great deal of anxiety and annoyance from a fault which should not have existed. The fact is, the makers of the engines could not be made to understand the immense importance in electric lighting of absolute steadiness in the running of the engines, or that there was any difference in the driving of dynamo machines and street tramways.

The Brush Victoria dynamos ran very well through the whole six months the exhibition was open. In the main they kept cool, though occasionally the thrust bearings showed an inclination to heat. The commutators ran with very little sparking when the brushes were properly adjusted.

Unfortunately, the above satisfactory remarks cannot be repeated with reference to the arc dynamos. In the first place, the insulation in many of them was defective or insufficient. Consequently, "electrical fireworks" formed a not unimportant part of the evening's proceedings, till such time as the faulty armatures and field-coils had either been rewound or weeded out. In many cases, the machines ran for several weeks without giving any indications of weakness, when suddenly a breakdown in the insulation would take place. Another fault, more serious (if possible) than the last, existed in some of the armatures—namely, those which have been designated "thin-plate armatures." All the laminated armatures supplied, both thick and thin plate, were built up of the so-called H pieces, bound in with a strip of sheet iron, equal in width to the intended thickness of the bobbin core. There was no indication of the H pieces having been passed between rollers, or anything done to give them the same curvature as the armature. The horns of the H pieces were practically flat, hence their resistance to bending was simply that due to the thickness of the metal, which is insufficient in the case of the thin-plate armatures. A few weeks after the opening of the exhibition several of the thin-plate armatures threw out plates. Two of these plates struck a door-post, and gave unmistakable evidence of the velocity with which they were thrown. On subsequent occasions the plates were not so neatly thrown out, but were caught by the field-magnets, and cut the insulation of the armature-coils. By the time the exhibition closed a goodly number of plates had been thrown out. To prevent accidents perforated zinc screens were placed over the armatures.

The cause of these plates breaking off was evidently the

continual bending to which they were subjected in passing through the different parts of the magnetic field in which they rotated. The force due to the rotation of the armature tends to bend the plates outwards, while that due to the attraction of the pole-pieces has the opposite tendency (at least with reference to the outer plates). Clearly, then, though the force due to rotation is constant, as the plates pass through a magnetic field which is not uniform in intensity or direction with reference to any given armature radius, the force tending to bend the plates inwards must vary in different parts of the field, and a constant bending of the plates must result. This mechanical fault was a very serious one, and might have caused damage to life and limb.

Before describing the methods used and tests made with the dynamo machines, it may not be out of place to give a few of the reasons which led to the selection of the method adopted. In order that the tests should be equally satisfactory to all concerned, it was essential that the machines should be tested under the actual working conditions, or while they were at work on their respective circuits. It was not thought to be important that all measurements taken should be of the highest degree of accuracy. As practical engineers know, the conditions of running do not remain constant (especially in arc machines) for many consecutive moments, and the fluctuations which take place affect all data, and the resulting efficiency from instant to instant. Hence the desire was to make tests which would be of practical, rather than theoretical, value.

The many more recently-suggested methods of testing dynamos in which all the measurements taken are electrical, such as Cardew's and Swinburne's, or in which the mechanical is the smaller part, such as Dr. Hopkinson's, were carefully considered with reference to the special form of machine to be tested. Of these methods, that of Captain Cardew seemed to be the only one that would give satisfactory results, for by it the machines can be tested under the actual conditions of working.

Now that it is no longer thought that a dynamo is simply a generator of electricity, and as such may be used indiscriminately for any purpose to which electricity is applied, makers designing special forms of machine to meet the different requirements for which they are to be used, the importance of considering the behaviour of the machine when working under the exact conditions for which it was designed cannot be over-estimated.

In considering the matter, the many advantages, from a mathematical standpoint, of selecting one of the above-mentioned methods, or of running the machine on a closed metallic circuit, could not be overlooked. How much more satisfactory it would be to have the current almost absolutely steady, without those fluctuations caused by a faulty lamp or a bad carbon, which make the readings of the instrument used in testing so irregular, and so difficult to obtain with any degree of accuracy. But the machines were not made to run on closed metallic circuit, and, if they are to be tested fairly, must be tested with all the fluctuations of current, friction caused by pull of belt on bearings, and other modifying influences which exist under the normal condition of working.

In some classes of machine, where the commutator has many segments, and each section of the armature winding has but few convolutions, especially if the machine is intended to light incandescent lamps or charge secondary batteries, the chances of error in any of the above methods would be a minimum. But with machines like the Brush arc dynamos, where the commutator segments are few, and the number of windings per armature-coil very great, the errors introduced by running the machine on closed metallic circuit instead of the ordinary lamp circuit for which it was designed may be considerable, unless the metallic circuit is arranged to have the same self-induction as the lamp circuit. With such machines as the Brush, the current should be maintained as nearly as possible at the value for which the machine was designed, as small alterations in the current may produce sensible alterations in the behaviour of the machine. The tests should be made when the machines have attained their state of steady temperature. It is, of course, needless to insist that the machine shall on each and every day reach its state of

steady temperature, as the atmospheric temperature may vary considerably. It is sufficient if the machine attains a temperature which would be its steady state with some known atmospheric temperature within the range of practical work.

If Dr. Hopkinson's method, where two similar machines have their armatures rigidly connected, were used, it would be needful to consider the exact relative angular position of the corresponding coils in the two armatures. If this were not attended to, the armatures might be so connected that the periodic fluctuations of the current would be either increased or diminished by the combination of the machines; hence the conditions of practical work might not be attained. In any case, with the two machines directly coupled (electrically), as suggested either by Hopkinson or Swinburne, the modifying effect of the self-induction of the circuit on the current fluctuation would be lost.

For these and other reasons the elegant methods adopted by Hopkinson and Swinburne were deemed unsuitable in this particular case. Cardew's method was also rejected as being unwieldy, necessitating as it does the removal of the machines, and so many belt transmissions.

As no other purely electrical method was thought of, it was determined to adopt the method involving the use of a mechanical dynamometer for measuring the energy absorbed by the machine, and to measure the output by the ordinary electrical method.

The chief disadvantage of this plan appeared to be in the necessity of having all the instruments used accurately calibrated. The efficiency would not be the ratio of two sets of measurements taken by the same instrument, or even by two different sets of instruments which could be directly compared *inter se*. But as there is no great difficulty in the calibration of electrical instruments, at least within a degree of accuracy sufficient for all practical purposes, and the mechanical dynamometer can be directly tested, the increased facilities for testing the machines whilst actually working on their respective circuits was considered sufficient to outweigh the disadvantages of the method.

In all efficiency tests but one, Siemens electro-dynamometers were used to measure the current. For some other tests Ayrton and Perry's meters, of both spring and magnet forms, were used. The values of the readings of these instruments were carefully determined by comparison with the electro-dynamometers. The latter instrument was calibrated by connecting it in series with a battery, an adjustable resistance, and a fixed resistance consisting of a large number of small german silver wires arranged so that any number could be put in parallel. The massive terminals to which the small german silver wires were fastened were connected through a very sensitive reflecting galvanometer and a standard Clark cell. A key was, of course, placed in each circuit. With a given number of german silver wires in parallel, the current through the total circuit was adjusted by means of the variable resistance till the potential difference at the terminals of the german silver wires was equal to the E.M.F. of the standard cell. The exact resistance of the german silver wires was immediately measured by the aid of one of Elliot's metre bridges. A small standard resistance was constructed from a piece of the same german silver wire as that used in the fixed resistance. The exact value of this coil was found by comparison with one of Elliot's standard B.A. units. All apparatus to be used was placed in position some time before required, to allow the temperature of all parts to become equal. The temperature was taken by a standard thermometer, which had been tested at the Kew Observatory. Two standard cells were used—one by L. Clark, Muirhead, and Co., the other made up at the time in accordance with Lord Rayleigh's instructions, whose formula for the variation of the E.M.F. of the cell with change of temperature was used. The two cells when tested were found to be almost exactly equal. No difference could be detected when they were compared by the condenser and ballistic galvanometer. But a very small difference did exist, and was shown by the deflection on a sensitive reflecting galvanometer when the cells were connected zinc to zinc, the remaining terminals being connected to the galvanometer.

In all calibrations some measurements were taken with each of the standard cells. The results of the calibration tests of the Siemens electro-dynamometer gave the value of the constant = .8716. The constant as given by the maker was .87—a difference of less than one-fifth per cent. The same electro-dynamometer when compared with one of Ayrton and Perry's latest spring ammeters differed by very little more than .01 per cent.

Two voltmeters were used—one of Ayrton and Perry's spring form, the other of the electro-dynamometer pattern. Both of these instruments were wound with copper wire, and large resistance coils of german silver wire, differentially wound, were used to reduce the potential difference at the terminals of the instrument proper. The voltmeters were calibrated in exactly the same manner as the current-meters. They were also checked by measuring the potential difference at the terminals of a known resistance by means of the condenser and ballistic galvanometer. These two methods gave exactly the same results in several tests, and the condenser method was ultimately discontinued, owing to the difficulty of obtaining a place where the ballistic galvanometer could be used without interference from locomotives moving in the vicinity. The dynamometer voltmeter was afterwards compared with one of Ayrton and Perry's spring meters: for 100 volts the difference in their readings did not exceed one-tenth of a volt.

The metre bridge was calibrated by Carey Foster's well-known method. An additional correction had to be made for the heating of the gauge wire by conduction from the binding screws. No special means were previously employed to prevent error from this source, as it was not anticipated that the effect would be appreciable.

The selection of a suitable mechanical dynamometer was not easy. The following conditions were laid down as essential: 1. It must be susceptible of a fair degree of accuracy, and show instantly any variation in the load. 2. It should be of such a form that errors are not likely to arise from the difficulty (owing to the thickness of the belt) of accurately determining the virtual radius of the pulley; and no power should be absorbed between the point at which the pressure is measured and the dynamo spindle. 3. Any springs contained must be so placed that centrifugal force will not introduce uncertain effects on the indications of the instrument. 4. It must be portable, and easily fitted up.

The first condition simply requires that whatever the principle involved it shall be faithfully executed, and that the moment of inertia and number of moving parts shall be as small as possible. The second condition requires that the power shall be transmitted to the spindle of the dynamo at some fixed distance from its axis of rotation, and that it is the pressure at this point which is shown on the indicating mechanism.

The simplest way of fulfilling the above conditions seemed to be to give the dynamometer the form of a pulley to be directly applied to the spindle of the machine tested. It is important that the displacement of any of the parts of the mechanism shall be very small, even though the indicator passes from zero to its maximum reading.

(To be continued.)

SOME METHODS OF REGULATING ACCUMULATORS IN ELECTRIC LIGHTING.*

BY GEO. B. PRESCOTT, JUN.

In preparing the following paper, the limited scope of which is indicated by its title, I have assumed that it is generally conceded that the modern electric accumulator is an apparatus capable of performing a peculiar but useful function in the art of electric lighting as now commercially practiced, and that it is free from defects which would render it unsuitable for such application. Indeed, I am sure that every careful observer has noted in the somewhat slow evolution of the accumulator that structural improvement and adaptation to practical requirements which unquestionably show that it has come to stay, and will acknowledge that even as it exists to-day the accumulator is a factor in electrical industry too important to be ignored by those who take a broad view of the situation.

* Paper read before the American Institute of Electrical Engineers, New York, October 29, 1889. From an advance proof from the *Electrical World*, New York.

It is not my intention to refer to those numerous successful applications of accumulators to the propulsion of small marine vessels and land vehicles, to car lighting and other minor work where the continuous generation of power from the combustion of fuel would be impracticable; neither can I fully discuss their characteristic actions under working conditions, within the limits of this paper. Nevertheless, before proceeding to the subject proper, I deem it incumbent to point out that the electrical accumulator, even in its more improved forms, is an apparatus having well defined limits of capacity, and that these limits cannot be habitually exceeded without endangering its effectiveness and impairing its durability. Generally speaking the limits referred to, which vary with every type and size of cell, relate to the rate and quantity of charge and discharge, these factors being measured respectively in amperes and ampere-hours.

In considering this admission, however, it should not be forgotten that every dynamo-electric machine is, to a certain extent, subject to similar limitations, for, like the accumulator, if it is demanded of them, they are capable of generating a current far exceeding their safe carrying capacity. Here the likeness ceases, however, for while the dynamo will deliver its normal current as long as adequate power is applied to its shaft, by continuing to draw current from an accumulator for too long a time, as likewise from an excessive rate and quantity of charge, serious damage may result. In fact, in some respects an accumulator may be likened to a draught animal, which can be made to perform abnormally large amounts of work for short periods of time, but only at the expense of its vitality if the practice is frequent.

While much might be said regarding the maintenance of accumulators, and, moreover, the apparatus to be presently described is employed in a large measure for the purpose of effecting proper maintenance as well as regulation, it must suffice to say here that the normal working rate and capacity of an accumulator battery having been stated by the makers, all necessary data relating to its use may be ascertained from the indications of ordinary hydrometers, ammeters, and voltmeters. That is to say, during the charge and discharge of such a battery the rise and fall of its potential and of the specific gravity of the electrolyte in its cells, are both quantitatively indicative of its condition and capacity for doing work. It is evident from what has already been said regarding the importance of working accumulators within certain prescribed limits, that in order to effect this result two classes of apparatus must be provided with every accumulator installation—viz., indicating or measuring instruments, and regulating appliances to be operated either automatically or by hand. I am constrained to add here that careful and extended observation leads me to believe that a lack of appreciation of these now obvious facts will largely account for the ill success attending many of the earlier accumulator installations.

Although there is reason for believing that some of the early promoters of business enterprises based on the manufacture of electrical accumulators, anticipated that accumulator systems of lighting were destined to compete with and perhaps supersede many direct systems, I believe that the more mature modern idea is that they are, for the present at least, mainly subsidiary to other electric lighting systems. As auxiliaries to many direct systems, accumulators undoubtedly effect a reduction in running expenses, and add an element of reliability, besides accomplishing certain results that are not otherwise obtainable. In order to fully appreciate the truth of these statements, it will be necessary to glance at the conditions commonly existing in ordinary isolated and central station plants as they are operated at the present time. Doubtless everyone who is familiar with the electric lighting business is acquainted with the vagaries of the load curves during each 24 hours of a central station's run. Generally speaking, about sunset the load begins to increase gradually, finally reaches a maximum which is maintained for a greater or less period of time, and then falls to a minimum, about which it fluctuates for the remainder of the 24 hours. Almost every isolated plant, whether it be in office building, hotel, or apartment house, has a curve of the same general character; and probably most manufacturing establishments would prefer to have a few lights burning through the night, if only for the watchman's convenience, were it not for the expense entailed by the continuous operation of the plant. It is a truism to say that the cost of fuel per horse-power increases inversely as the power plant operates below its normal capacity, and that other operating expenses are, to a considerable extent, fixed independently of the load. In view of these facts, it is universally acknowledged that the operation of large power plants of any character during periods of light loads, is enormously wasteful. Many have hoped that the supplying of current to small electric motors during the day would remedy the evil in lighting stations, and to some extent the expectation has been realised in manufacturing centres; but even here the unfortunate overlapping of the motor and lamp service still leaves an undesirable margin.

Here, then, is a field in which accumulators may perform their special function, not in competition with direct systems, but as supplying the missing feature in the commercially successful operation of 24-hour plants of moderate size. There is no obstacle in the way of applying a sufficient number of accumulators to a plant of the character mentioned, to maintain the light load during the time it would not pay to operate the power plant, and to provide for the charging of the accumulators during the regular running time of the dynamos. Assuming, in illustration of this statement, that 10 hours is the ordinary working day, and that the engines of a central lighting station are started at 2 p.m. and are operated until midnight, it is probable, if not certain, that there will be sufficient surplus current for an ample length of time to charge enough accumulators for the service required after the engines cease to revolve, excluding, of course, the period of maximum load, when the dynamos will be taxed to their full capacity in their regular service. Under such conditions the engines could be operated

at somewhere near their normal capacity during the whole period of their running time, and the cost of unit power would be a minimum, while only one staff of men will be required. It may be advisable to explain here that although the current available for charging the batteries during the regular running time of the dynamos would vary with the lamp load, this is of no importance, as it is not essential that the batteries should be charged at a uniform rate. In the case of such stations as also supply arc lights, the engines could be started later, and operated through the night. Besides reducing the operating expenses of a station during its periods of light load to a greater extent than they increase them at other times, in the event of an accident to the power plant or incandescent dynamos, the accumulators can always be called upon for extra service, while whenever there is an abnormally heavy demand for current they may also be operated in conjunction with the dynamos.

But there is still another field in which accumulators may be employed to equal advantage—viz., that of long-distance lighting now so successfully occupied by the alternator-converter system. An accumulator is, indeed, merely a chemical converter, which is unequalled as a pressure reducer, and anyone who gives careful thought to the subject will perceive what an excellent substitute it is for the alternator-converter in those situations where the character of the lighting makes it necessary to run "light" for many hours each day. Indeed, I can only account for the fact that accumulators were not long since more extensively used for this class of lighting, except by the existence of a feeling of scepticism as to their durability, together with their somewhat formidable first cost.

As manufacturers now guarantee the durability of accumulators, under certain conditions of use, for an annual percentage on their first cost, and as methods of manufacture must improve with experience and moderate that cost, both of these objections are gradually being modified.

But even in the present state of the art, the question of first cost, depreciation and efficiency may be duly allowed for, and a considerable reduction in operating expenses still shown to result from the use of accumulators under many circumstances. To quote from an article by the writer "On the Place of Accumulators in Electric Lighting," which was published in the March issue of the *Electrical Engineer*:

"Whenever one kind of energy is transformed into another kind, more or less loss can be shown to occur, and the action of the accumulator is not an exception to this rule. The proportion of loss generally varies with the conditions under which the transformation is effected, and in the case of the accumulator depends mainly upon the rate of charge and discharge. If these double transformations are conducted slowly the loss may be nearly inappreciable, but at the higher rates which are frequently demanded in practice the efficiency is proportionately reduced. The fact of the existence of this loss clearly indicates that the direct production and consumption of electricity must always be less expensive, both in original outlay and cost of production, than its subsequent use through the medium of accumulators; unless, indeed, there are other modifying conditions which overbalance the additional cost of accumulators and offset their maintenance. That such conditions do exist in many branches of the electric lighting industry can be readily demonstrated, and it may likewise be shown that the use of accumulators as auxiliaries to many existing lighting plants would ensure a marked reduction in their running expenses."

From what has already been said regarding the infallible certainty of loss resulting from any form of conversion of energy, it is evident that if the load were equal to the capacity of a plant for 24 hours each day, no system of conversion could compete in point of economy with one which effected the direct production and use of the current. There is an exception even to this general statement, however, when one or more groups of lamps are located at such a great distance from the source of power, that the interest on the cost of conductors, together with the cost of the energy wasted in them, becomes of serious importance, not to mention the increased difficulties of regulation. In cases of this character, the value of the accumulator as an auxiliary to a direct incandescent system becomes obvious. The cells may be located directly at the centres of consumption, and charged by a moderate current at high pressure over a small conductor. They may be charged during the hours of light load, and discharged as required, the whole charging current, in addition to the current of the batteries, being available on the lamp circuits during the period of maximum load, if it should be so desired. Often the interest on the cost of such an accumulator installation, plus the cost of the energy lost in conversion of current, is much less than the loss by the direct system as previously specified. Another and vastly important consideration in favour of the accumulators is that during the 10 or 12 hours of each day when the consumption of current is so small that a station can only be operated at a loss, the power could be shut off entirely and the accumulators resorted to for the current required during that period.

As a matter of fact, the ideal condition of a continuous maximum load, as assumed above, nowhere exists in practice. The actual load curves for stations of similar capacity throughout the country differ not only in respect to the duration of the maximum period, but likewise in the hours during which the light and heavy loads occur, according to the character of the lighting. It is nevertheless true that they all show a remarkable similarity in the variation of current consumption, and all the 24-hour stations, particularly the smaller ones, require but a very small portion of the capacity of the plant for the greater part of the day. For this reason, many of the smaller stations cannot be profitably operated for more than 12 hours a day, and customers are therefore unable to obtain the light for the remainder of the 24 hours, the system being thereby deprived of much of its value to many customers.

Here, again, the utility of the accumulator for tiding over these costly periods of light loads becomes apparent. It is evident that

any ordinary station running for 12 hours a day, more or less, is not likely to have an output approaching its capacity for more than two hours at the longest, while for the greater part of the time it will be much below it. Why should not such a station be operated during that period of 12 hours at somewhere near its full capacity, and, therefore, under the most economical conditions for the power produced, and utilise the excess of current to charge a sufficient number of accumulators to maintain the lighter load during the remainder of the day? This is the legitimate work of accumulators, and when they are properly installed and maintained to meet such conditions, the class of small stations referred to will be enabled to supply satisfactory light for 24 hours a day at moderate cost, while the larger stations may greatly reduce their running expenses, and at the same time maintain the efficiency of their service.

Before proceeding to consider the methods of regulating accumulator currents, it will be advisable to examine some of the peculiarities of the element with which we have to deal. Generally speaking, the total current capacity, expressed in ampere-hours of a single cell of accumulator of the lead lead-oxide type, is proportional to the number and size of its plates; its rate of discharge depending upon the number of plates and the effective surface of each, while the time of such discharge varies with their thickness. Although there are no obvious theoretical reasons why a single cell of accumulator should not be made sufficiently large to possess any desired capacity, there are mechanical considerations which make it advisable to limit the dimensions of a cell to the extent that it may be conveniently portable. Therefore, when higher rates or longer discharges than an ordinary cell will give are demanded, two or more cells must be connected in parallel. On the other hand, the E.M.F. of all sizes of accumulators composed of the same elements is of course identical, but as the internal resistance of a cell varies with the number and service of its plates, its effective working potential must be a function of the strength of the discharge current. As, however, the internal resistance of all sizes of accumulators is, in virtue of the large surface and compactness of their electrodes, exceedingly small in comparison with their rate of discharge, their working potential nearly equals their E.M.F. on open circuit. While the normal effective working potential of a fully charged accumulator in good condition is usually stated as about two volts, as a matter of fact it is somewhat higher than this after being charged and rather lower after normal discharge, the average effective potential being about 1.95 volts. During the operation of charging an accumulator, its potential, or what is then usually called its counter E.M.F., rises gradually until the cell is nearly charged, and then more suddenly as gas is evolved, sometimes requiring an effective charging pressure of as high as 2.5 volts per cell if the current is continued after the cell is charged. In actual practice the accumulator is usually considered to be fully charged when the potential of the normal charging current reaches 2.3 volts per cell, or at 2.2 to 2.25 volts per cell when the charging rate is reduced as gas begins to be freely evolved towards the end. Similarly when a cell is discharged at the normal rate its effective potential falls during the progress of the discharge from two volts to 1.8 volts, at which latter point it is considered to be discharged to its normal limit.

The facts above cited, to the effect that the E.M.F. of accumulators rises during charge, and falls during discharge, and that their capacity for charge and discharge is limited, are the keystones to the regulative processes, and only one other point need be here considered. When two or more series of cells connected in parallel are to be charged at the same potential, it is evident that unless each series is in precisely the same state in respect to residual charge, there will be a difference in their E.M.F.'s, and, in consequence, less current will flow in those series having higher potentials than others. While the larger current flowing into the less-charged cells will have a tendency to bring up their potentials to the average, it is found in practice that some series will become fully charged sooner than others. The simple means provided for compensating for these variations will be duly described.

One of the commonest, and perhaps the simplest, applications of accumulators to lighting work is found in their employment in connection with direct isolated plants in factories, office buildings, etc. In illustration of the method of applying accumulators in such cases, we may select as a type of this class of lighting one of those office buildings common in New York and other large cities. This building, we may assume, has already been, or is about to be, wired for 500 16-candle, 100-volt, $\frac{1}{2}$ -ampere lamps on the multiple arc plan, and is to be provided with a 125-volt, 200-ampere dynamo, it being calculated that more than 400 lamps will rarely be lighted simultaneously. We are not specially concerned with the power plant, and will simply assume that it is of ample capacity, it being remembered that such buildings are usually steam heated, and therefore offer favourable conditions for the operation of a plant of the character under consideration. Now it can be deduced from experience, that during the day from, say, 9 o'clock in the morning until about sunset, only a limited number of lights will be burned in certain dark corners of the building, and that as twilight and darkness come on the load will gradually increase, reaching a maximum at a certain hour depending upon the season; subsequently the load will decrease, finally reaching a minimum after the janitor and his assistants have finished their cleaning operations, which load will probably be maintained for the remainder of the 24 hours. It is evident that a direct plant operating under such conditions would necessitate the employment of two forces of men, either one or two in each, and would, moreover, be running under exceedingly uneconomical conditions for a large part of the time. Let us now consider in what manner accumulators may be added to this plant in order that it may supply the variable load for 24 hours daily, while at the same time dispensing with the services of one staff of men and reducing the running time of the engine to eight hours.

It has been shown in a general way how the load varies during 24 hours; but in order to ascertain the capacity of the accumulators required, it will be necessary to assume, though only approximately, somewhat more precise figures. Say that the load is as follows:

From 9 p.m. to 9 a.m.,	20 lamps=120 ampere-hours.
" 9 a.m. to 4 p.m.,	200 " =700 "
" 4 p.m. to 6 p.m.,	400 " =400 "
" 6 p.m. to 9 p.m.,	50 " =75 "

An inspection of the above schedule shows that for 12 hours out of the 24 only 20 lamps, or 10 amperes, are used, while for three hours more only 50 lamps, or 25 amperes, are required; and a simple calculation proves that a set of accumulators having a capacity of 200 ampere-hours will be amply sufficient to maintain the light lamp load for 14 hours out of the 24. If the dynamo is started at 8 a.m. and operated until 6 p.m., while maintaining the required number of lamps during that period, it will still have surplus current for charging the battery, as follows:

From 8 a.m. to 9 a.m.,	190 amperes for 1 hour;
" 9 a.m. to 4 p.m.,	100 " 7 hours;

or 890 ampere-hours, an available capacity vastly in excess of the requirements. Now, if during the eight hours in which the dynamo is operating the accumulators are charged at the rate of 30 amperes, in that period they will receive a total charge of 240 ampere-hours. According to the schedule, the maximum output required from the battery will be 185 ampere-hours, whence it follows that the charge received by it is more than ample, even after making the customary allowance of 20 per cent. for loss by conversion, and the desired result has been accomplished.

We have now to consider the details pertaining to the practical arrangements of such an installation. According to the stipulated schedule, after the dynamo ceases to run at 6 p.m., the battery alone must supply 25 amperes for three hours, and thereafter 10 amperes for 11 hours, or a total output of 185 ampere-hours. One series of 50 cells having, say, a normal capacity of 30 amperes for eight hours, will satisfy these requirements, and may be well within the nominal rating of ordinary commercial cells. Assuming that these 50 cells, connected in series, have been suitably placed on insulated shelving at any convenient distance from the dynamo, they may be electrically connected with the latter and with the lamp circuit, as shown diagrammatically in Fig. 1.

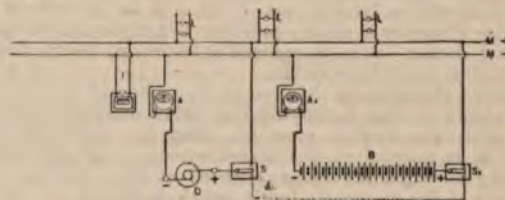


FIG. 1.

In this diagram the two parallel wires M (+) and M (-) represent the common dynamo and lamp mains to which the pressure indicator, I, is permanently connected in the usual manner; and L L L represent the lamp circuits. The dynamo, D, is connected to the mains; through the ammeter A_1 on one side, and through the upper contact of the two-way switch S_1 on the other. These are ordinary connections of a multiple arc plant; and the (+) and (-) terminals of the accumulator battery, B, are also connected with the mains through the ammeter A_2 and two-way switch S_2 in precisely the same way. It is evident that if the levers of both switches, S_1 S_2 , are against their upper contacts, the dynamo and battery will supply current to the lamp circuits in exactly the same manner as would two dynamos connected in parallel, provided, of course, that they are both at the same potential. On the other hand, if the potential of the dynamo slightly exceeds that of the battery, the current from the former will divide between the battery and the lamp circuit in a certain proportion determined by the ratio of the resistance of the lamp circuit to the internal resistance and counter E.M.F. of the battery. If the levers of the two switches, S_1 S_2 , are now moved to their lower contacts, the dynamo and battery will be connected in series with their like poles opposed, the main M (-) acting as part of the circuit, and supposing that the pressure of the dynamo still exceeds that of the battery, the latter will receive a charge. Thus, by this very simple arrangement, the dynamo and the battery, either separately or together, may be connected with the lamp circuit, or with each other, or be entirely disconnected.

While this method satisfies all but one requirement in certain classes of plants where it is convenient to employ the dynamo solely for charging the battery during a part of the day, and to use either the dynamo or battery, or both, in the lamp circuits at other times, it does not, in fact, satisfactorily permit of that splitting of the dynamo current between the lamps and battery which was incidentally referred to. More than this, it fails to provide a means of compensating for that rise and fall of the potential of the battery during charge and discharge which has been mentioned; and this is the unsatisfied requirement referred to above. The reason why the dynamo cannot satisfactorily divide its current between the battery and lamps when connected in the manner illustrated in Fig. 1 has already been pointed out. During the charging of the battery its potential will rise to 2.2 volts per cell, so that the pressure of the dynamo must be raised to 110 volts in the case now being considered, and this excessive pressure would endanger the life of the lamps. How, then, will it be possible to employ the higher pressure demanded by the battery and at the same time supply current to a

number of lower voltage lamps without raising their candle-power above normal? The answer is easily given, for it is only necessary to insert a suitable resistance in the main between the dynamo and lamp circuits in order to accomplish the desired result. Such a resistance, usually called a "pressure equaliser," should be made of wire sufficiently large to safely carry the current for the greatest number of lamps likely to be required at the time when the dynamo which supplies them is to be simultaneously called upon to charge the battery, and should be made conveniently adjustable, as the fall of potential through it varies with the current. The method of regulating the working potential of the battery is equally simple, for it merely consists in adding to or subtracting from the number of active cells in circuit. This is accomplished by means of a multiple-point switch, called a cell-regulating switch, shown diagrammatically in Fig. 2, which is so constructed that, in



FIG. 2.

the act of shifting the cells in and out of circuit, it neither interrupts the circuit nor short-circuits the cells. It consists essentially of a single pivoted lever, which carries on its outer end a short metallic arm. This arm is attached to the lever by means of a block of insulating material, but is electrically connected with it by a short spiral of german silver wire. The lever and arm may be made to pass over a number of contact strips, which are so arranged that, before the lever breaks contact at one strip, the arm comes in contact with the next strip, and the reverse action takes place when the lever is moved in the opposite direction. During the brief interval, while both lever and bar are in contact with adjacent strips, the cell connected to those strips discharges a feeble current through the spiral of wire.

It is necessary to mention here, that in practice it is customary to provide for the installation of 10 per cent. more cells in each series than a simple calculation on the basis of two volts per cell would show to be necessary. Thus a plant using 100-volt lamps would require $100 \div 2 = 50$ cells + 10 per cent. of 50 = 5, or 55 cells in each series. This allowance is usually sufficient to compensate for the fall of potential during discharge, as well as to provide for the ordinary loss of potential in the lamp mains.

The method of employing the pressure equaliser and cell-regulating switch is shown in Fig. 3, this diagram being otherwise similar to Fig. 1, with the further exception that an automatic break switch, B S, is inserted in the branch wire connecting the dynamo and battery through the lower contacts of the switches S_1, S_2 . The function of the automatic break switch is merely to interrupt the charging current, in the event of the potential of the dynamo becoming so much reduced from any cause as to allow the battery to overcome it, and perhaps reverse its polarity. This switch, a practical form of which was shown, consists of a simple electromagnet with a weighted armature lever carrying at one end an Ω -shaped bent wire dipping into mercury cups. The charging current passes through this magnet and from one mercury cup to the other through the bent wire. When the current becomes greatly reduced to any predetermined extent, gravity overpowers the attractive force of the magnet, its armature is released, and the bent wire being drawn out of the mercury cups, the circuit is broken. By referring to the diagram in Fig. 3, it will be seen that the pressure equaliser, P E, has been so placed that when the switches,

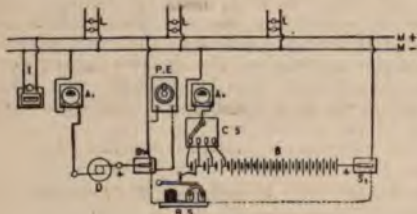


FIG. 3.

S_1, S_2 , are on their lower contacts, the current from the (+) pole of the dynamo would divide at switch S_1 , part going through the battery and part through the pressure equaliser to the lamp circuits, both currents again uniting at the M (-), main to return to the (-) pole of the dynamo. By this arrangement the potential of the dynamo may be adjusted to the requirements of the battery, and at the same time the pressure at the lamps suitably reduced by adjusting the resistance of the pressure equaliser.

When the proper balance is once obtained, and by means of this apparatus it may be quickly and easily accomplished by one man, no further attention than would ordinarily be given to the dynamo would be necessary, for although the counter potential of the battery would gradually rise toward the end of the charge, and the current passing into the battery become correspondingly reduced, this result is even desirable, as it is somewhat advantageous to reduce the strength of the charging current as the battery becomes filled. In some installations, however, the extra or regulating cells are used to a more limited extent than the others, and thus having had less current taken from them they become sufficiently charged in a shorter time. A simple movement of the cell-regulating switch will

then serve to cut out of circuit one or more of the charged cells as may be required, while the others receive current for a longer time. In some cases a further adjustment of the field rheostat of the dynamo and of the pressure equaliser may afterwards be required, and if so are quickly effected.

The first indication that the cells have received nearly enough charge will be given by the gentle evolution of gas, which gradually increases thereafter, and which should never be allowed to become violent. At the same time the potential of the battery will approach 2.2 volts per cell, and even reach above 2.3 volts per cell when the gassing becomes marked. In order to take advantage of this indication of charge it will be sufficient to have a voltmeter conveniently located and connected with the terminals of the battery, by means of which instrument, the number of cells in the battery being known, the potential per cell is readily ascertained. While this increase in potential is taking place, a similar variation in the density or specific gravity of the electrolyte in the cells also occurs, but this change, unlike that of the potential, remains fixed, even after the charging current is discontinued. That is to say, if the specific gravity of the liquid was 1.160 when the cells were normally discharged, it would rise to 1.190 when they were fully charged, and would remain at that for a considerable length of time if no current was drawn from them. This rise of 0.030 in the specific gravity of the electrolyte is about the average increase in density which takes place in the common types and sizes of accumulators when 1.160 acid is used in the original charge, and when the range is from the normal discharge to full charge. It often happens, however, that charging is commenced when the cells have more or less residual charge, and in this case the rise in specific gravity will be correspondingly less, while, on the other hand, it will be correspondingly greater if the cells were previously over-discharged. Again, if unusually large cells enclose the piles (as the aggregation of electrodes is commonly designated) the rise of specific gravity will be smaller, and, on the other hand, larger if unusually small containing cells are employed. As heretofore stated, a similar drop in specific gravity and potential occurs when the cells are discharged, which in degree has about the same value as the rise. This variation in specific gravity is explained by the formation of lead sulphate during discharge, which implies the absorption of acid from the electrolyte, and by the reduction of this sulphate during the charge when the electrolyte is strengthened.

While the method of installing a single series of accumulators in connection with an isolated plant, as described and illustrated in Fig. 3, fulfils most of the conditions required in small plants operating a single dynamo, in larger plants of a similar type using two or more dynamos, several series of the largest cells may be required. Although such an installation would consist mainly of an amplification of the system already described, still there exists a new difficulty not met with in that system. This arises from the fact already mentioned, that when several series of cells are charged in parallel, any essential difference in the amount of the residual charge in the several series results in their allowing different amounts of current to flow through them, although all of the series are charged at the same potential. The remedy for this undesirable result is of the same character as that employed to prevent excessive pressure on the lamp circuits, when the dynamo which supplies them with current is at the same time used to charge accumulators. In circuit with each series of cells is placed a small adjustable resistance-coil. It is composed of wire large enough to carry the maximum current of a single series of cells, and usually has a resistance of from 3.10 to 6.10 of an ohm. Each series of cells is also provided with an

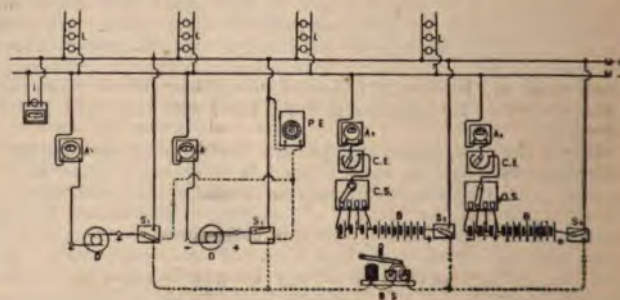


FIG. 4.

ammeter, and upon the commencement of a charge the current equalisers are so adjusted that each ammeter shows the same amount of current to be passing through each series. In order to avoid as much as possible any loss of energy in the current equalisers, they are all turned to the no-resistance point at the start, and resistance is then only inserted in such series as may be taking more current than others.

The general arrangement of an accumulator plant, consisting of two dynamos and two sets of batteries, is illustrated in Fig. 4, and a simple extension of this plan only is necessary to adapt any number of series of cells to a plant having any number of dynamos. It will be seen that one equaliser circuit, and one charging circuit, with its automatic cut-out, are common to all the dynamos that may be used. While this arrangement possesses all the flexibility of the method of installing a single series of cells, as shown in Fig. 3, it has the additional advantage that at such times as the load is below normal a spare dynamo can be exclusively employed for charging the cells, and thus avoid loss of energy in the pressure equaliser. As a general thing, when the current equalisers, C E, have once been adjusted at the beginning of a charge they need but little if any

further attention, still, if from any cause one series of cells should happen to be overdischarged, or discharged more than the remaining series, a suitable readjustment of the current equalisers will permit the undercharged series to receive current at a higher rate than the others, and thus equalise itself with the others. It may also be mentioned that both the pressure and current equalisers may be made to operate automatically by the application of a potential magnet to the former and of a current magnet to the latter, together with a simple but somewhat expensive train of gears to move their levers. This is found to be wholly unnecessary in practice, however, as an engineer is usually in constant charge of such a plant while the dynamos are running, and he can easily devote the little time necessary to the infrequent regulation required.

It was mentioned in the early part of this paper that it was possible to injure accumulators either by overdischarging them or working them at too high a rate. It is assumed that in the larger plants, there will be such supervision available under ordinary working conditions that occurrences of this kind will be avoided; but a simple device for preventing such abuse of the cells in smaller plants, where such supervision is not always convenient, has been devised. It is called an overload and overdischarge switch, and its operation is based on the fact that, when a series of cells is overdischarged, their potential falls below a minimum value, and that when they are worked above their normal rate the current exceeds a maximum value. The apparatus consists essentially of a pressure magnet connected to the terminals of the battery, and of a current magnet in series with the battery. When the potential of the battery falls below a minimum value the armature of the potential magnet is released and throws an artificial resistance into the battery circuit, and thus reduces the current; and similarly, when the current exceeds a maximum value the armature of the current magnet is attracted, and performs a similar function. The connections of this overload and overdischarge switch, O and P, are shown diagrammatically in Fig. 5,

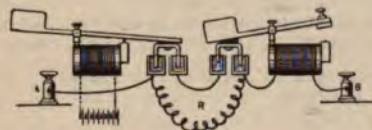


FIG. 5.

in which a common resistance, R, serves for either magnet. The battery current passes from A to B through the overload magnet, while the terminals of the overdischarge magnet are, as before stated, in shunt to the battery terminals.

With the object of reducing the cost of the regulating apparatus whenever both the combined overload and overdischarge switch and the current equaliser are to be used with the same series of cells, the switch portion of the equaliser may be mounted on the resistance-frame, and thus a single resistance-coil be made to do service for both instruments. This combination, of which the connections are shown in Fig. 6, while allowing the current equaliser switch to control the

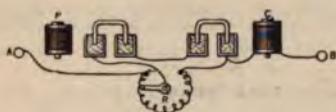


FIG. 6.

full range of resistance, at the same time causes the whole coil to be thrown into the battery circuit upon the operation of either the overload or overdischarge switch. This, of course, diminishes the brilliancy of the lamps, and thus indicates the state of affairs to those interested.

(To be continued.)

COMPANIES' MEETINGS.

TAUNTON ELECTRIC LIGHTING COMPANY.

An extraordinary general meeting of the Taunton Electric Lighting Company was held at the Castle Hotel on Tuesday evening for the purpose of confirming a resolution passed at an extraordinary general meeting of the Company on the 21st October, which was as follows: "That the capital of the Company be increased by creating 2,000 new shares of £5 each, and that the Directors be empowered to offer, in the first instance, to the shareholders of the Company willing to accept the same, and in proportion to their several holdings, and subject thereto to issue and allot in such other manner as the Directors may think expedient, all or any of such new shares, at such time or times, and at any premium, and generally on such terms and conditions in all respects as the Directors may determine."

There were present, Mr. J. H. Bale (in the chair), Messrs. H. G. Massingham (managing director), E. Waldegrave, G. H. Kite, A. Lewis, N. Norman, Councillor W. Potter, Councillor J. Goldsmith, A. Stevens, E. Potter, A. Fouracre, H. Franklin, E. Hellard, H. Read, A. Goodman (auditor), and F. C. Bostock (secretary).

The Chairman remarked that in their presence that evening he recognised the interest which they took in the Company,

and their desire to promote its success. That was a purely formal meeting, held for the purpose of confirming the resolution passed at the previous meeting. Before proposing the resolution, he said he should like to say that in the face of all the large expenditure which was taking place at the depot they would recognise how necessary it was that they should raise considerable capital within the next two months, and the Company would be glad if all the gentlemen present would see their way to increasing their holdings and at the same time induce their friends and acquaintances who were not cognisant of the position of affairs to take an interest in the Company. He was satisfied that their electrical company would be a great success, and he had no doubt at all that within the next three or four or even six months, the whole of the 3,000 10-c.p. lamps which they purposed to provide would all be applied for. If that were so there could be no question but that the success of the Company would be ensured. Notwithstanding the large increase of capital, of course it was not proposed to call up the whole of the £10,000, but only to call up so much as they needed to pay expenses incurred by the erection of the works and to secure a small amount of working capital. When this had been secured they would cease for a time to issue shares, and only ask for more capital as necessity arose for it. In conclusion, he proposed the confirmation of the resolution.

Mr. Massingham seconded, and proceeded to give some idea of the plan to be put down at the new depot. In the first place, they were putting down two Babcock and Wilcox boilers, each of 150 h.p. when working at a pressure of 140 to the square inch. At the present time they had two boilers supplying 75 h.p., and the two they were now putting down would supply 300 h.p., so that they were making ample provision for extensions. They were also putting down two Ruston and Proctor engines, each of 75 h.p., and these would drive the whole of the present plant, which takes the two engines giving 75 h.p. between them. One of these would do the work now, and the other would be a duplicate; they would be used principally for the arc lights, motors, and one thing or another. In addition to this there would be two engines of 100 h.p. each, by Willans and Robinson. Each would drive a new dynamo for incandescent lighting on the new Thomson-Houston system of incandescent lighting, by means of which they could light a square area of 20 miles from one centre. The electricity would be sent through a small wire at 2,000 volts pressure, and in each house would be put a transformer or converter, which reduces the pressure from 2,000 volts to 100 volts, which was a perfectly safe pressure, and could be used by householders without any danger or inconvenience. Each of these dynamos would supply 3,000 incandescent lamps. The whole of their plant in every part would duplicate. As, perhaps, most of them were already aware, the order for the whole of the new standards was given to a local firm—Messrs. Allen and Son; the order for the whole of the countershafting, steam-pipes, and all accessories, and fixing the engines had been entrusted to Messrs. Easton and Waldegrave, so that with the exception of a pair of boilers and engines, which could not be manufactured in Taunton, he was pleased to say that the work had been given to local firms. He thought and hoped that the introduction of the electric light in Taunton might assist in bringing local engineering firms to the front. It was not improbable that they might be asked—they had already been asked to tender outside the town, both at Bath, Bristol, and London. At the American Exhibition a number of accessories were supplied by Taunton firms, Messrs. Allen and Co. and others. Messrs. Allen had also supplied the towns of Bath and Exeter. What his (Mr. Massingham's) object was was to give an impetus to the engineering industry of the town. It was a point in their favour that all the places of the United Kingdom where the electric light was now being successfully introduced owed their origin to what had been carried out at Taunton for years. Such a statement coming from a technical journal was very gratifying. When the electric light was first introduced it was looked upon as a disastrous failure, but it was left to Taunton to prove that electricity could be made for lighting purposes both a financial and electrical success. Theirs was the most successful record that could be shown in the country.

The resolution was then put and carried unanimously.

Mr. Stevens proposed a vote of thanks to the Chairman, and this was seconded by Mr. Franklin, carried, and acknowledged.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.

The shareholders in this Company held their twenty-fifth half-yearly ordinary general meeting on Wednesday, at Winchester House, Old Broad-street, under the presidency of Mr. C. W. Earle (the chairman of the Company).

The Chairman, in proposing the usual resolution for the adoption of the report and accounts, said that although a submarine telegraph company which was only able to show an available dividend at the rate of 3½ per cent. could not be called a very successful enterprise, he thought the shareholders of the old India and Panama would be disposed to look with some satisfaction upon the report which the Directors were able to present to-day. It was, as a matter of fact, the best report in its result that they had ever had the honour of laying before them. There was an increase in the traffic revenue over the corresponding half year of £672, which he hoped would be regarded as satisfactory. That, however, did not bring their traffic of this half-year up to the best that they had ever achieved. The last one that was better in point of traffic was in 1883, which was a long time ago. There was a slight increase in the working expenses, caused by the incidental fluctuations to which working expenses were exposed in the increase of the length of service on the part of their staff. On the other hand, there was a decrease of £3,459 in the expenses for the repairs to cables. That was a satisfactory item,

which he hoped would continue to decrease. Their average for the previous half-year had been about £13,000, as against £11,000 this half-year, so that they were about £2,000 under what they had spent on an average in the six months. With regard to their present position and the immediate future, he felt that it would be touching upon rather ticklish ground if he were to say much upon that subject. In conclusion, he expressed the hope that the shareholders would keep themselves cool in the matter of the value of their shares.

Mr. William Ford (director), who seconded the motion, alluded to the recent criticisms which had, he said, appeared in certain financial newspapers, and gave it as his opinion that if those papers would give the "whole truth" and not "partial truths," which were often exaggerated and very misleading, it would be much better alike for shareholders and the public interested in financial matters. The Company had so strengthened and vitalised the original cables that he thought they might rely upon their doing good work and service for many years to come.

The report was then agreed to, and the dividend having been declared, the meeting, after paying the usual compliment to the chairman, came to a close.

WOODHOUSE AND RAWSON UNITED, LIMITED.

The first general meeting of the shareholders of this Company has been held at Winchester House, Old Broad-street.

Sir R. W. Rawson, who presided, stated that there were no resolutions to submit, the shareholders having been called together simply to comply with the legal formalities of a statutory meeting. All the essential measures connected with the constitution of the Company and the amalgamation of the businesses of the several companies which were now united in their own undertaking had been completed. A very important and, they hoped, very profitable contract, which was in negotiation at the time of the formation of the Company, had since been completed, and the Directors were justified in assuring the shareholders that the prospects held out in the original prospectus would be realised. By organisation they had economised very largely the costs of administration, and by the possession of increased capital they had received large and important offers of business.

Sir J. C. Stokes, K.C.B., said he desired to confirm the Chairman's statement as to the prospects of the Company.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for the week ended November 8 amounted to £4,636.

Woodhouse and Rawson United, Limited.—The offices of this Company have been removed to 88, Queen Victoria-street, E.C.

Western and Brazilian Telegraph Company, Limited.—The traffic receipts of this Company for the week ended November 8, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,172.

Crompton and Company, Limited.—The Directors have declared an interim dividend of 7 per cent. per annum on the preference shares for the six months ending September 30, payable on the 14th of December, carrying forward sufficient to pay the preferential dividend at the same rate for the next six months.

Greenwood and Batley, Limited.—The Directors of this Company have declared the following interim dividends for the half-year ending September 30 last, payable on and after the 14th inst.: At the rate of 7 per cent. per annum on the 7 per cent cumulative preference shares, and at the rate of 10 per cent. per annum on the ordinary shares.

PROVISIONAL PATENTS, 1889.

NOVEMBER 4.

17511. **Improvements in devices for preventing the action of strong electric currents upon weak currents.** Carl Coerper, 45, Southampton-buildings, London. (Complete specification.)

17521. **Improvements in the distribution and regulation of electric currents.** William Clark, 53, Chancery-lane, London. (Sigmund Schuckert and Co., through Wirth and Co., Germany.)

NOVEMBER 5.

17581. **Improvements in apparatus for regulating and commutating electrical currents, applicable for use in dynamo electric machines, motors, and meters.** Henry Francis Joel, 44, Lavender-grove, Dalston, London.

17610. **Improvements in electric signalling apparatus, chiefly designed for police service.** Henry Harris Lake, 45, Southampton-buildings, London. (Frank Edward Morgan, United States.)

17611. **Improvements in electro-medical apparatus.** Cornelius Bennett Harness, 45, Southampton-buildings, London.

NOVEMBER 6.

17643. **An improved method, by means of electricity, of reducing friction in bearings and other parts of machinery.** Charles Brotherhood, Bristol Bank Buildings, Bristol.

17652. **Improvements in electric arc lamps.** John Hall Rider, The Northern Telegraph Works, Halifax.

17675. **A new or improved apparatus for governing the electro-motive force of dynamo-electric machines, driven by gas engines and other impulse engines.** William Aloysius Higginbotham, 9, Westland-row, Dublin.

17694. **An electrical Watt meter.** Ernest Wilson, 28, Southampton-buildings, London.

NOVEMBER 7.

17754. **Improvements in conductors of electrical energy.** John Marshall Spink, 55, Chancery-lane, London.

17762. **Improvements in electrical switches.** Frederick Lawrence Rawson and William White, 11, Queen Victoria-street, London.

17763. **Improvements in or applicable to electrical switch-boards and switches.** Frederick Lawrence Rawson and William White, 11, Queen Victoria-street, London.

17781. **An improvement in electric switches.** William White, 28, Southampton-buildings, London. (Complete specification.)

NOVEMBER 8.

17785. **Electric burglar alarm contact-hinge.** William Smith, Spring Hill Cottage, Upper Clapton, London.

17793. **Improvements in galvanic batteries.** George James Weir and Archibald Weir, Hillcrest, Partickill, Glasgow.

17819. **Improvements in switches for making and breaking electric currents.** Alfred Slatter and William Rixon, 140, Salisbury-court, Fleet-street, London.

17831. **Improvements in electric battery, carbon, and carbon compound elements and their connections.** John Vaughan Sherrin, 77, Chancery-lane, London.

NOVEMBER 9.

17914. **Electrically controlled steam steering gear.** William Clark, 53, Chancery-lane, London. (Sigmund Schuckert and Co., through Wirth and Co., Germany.) (Complete specification.)

17915. **Improvements in the operation of telegraph circuits and in apparatus therefor.** Charles Adolph Gisborne, 77, Chancery-lane, London. (David Herbert Keeley, Canada.) (Complete specification.)

SPECIFICATIONS PUBLISHED

1888.

10245. **Electrical safety cut-outs.** Perrett. 8d.
 14843. **Electric meters.** Oulton and Edmondson. 3d.
 15183. **Electrical telegraphs.** Edwards (Cassalette and Kunhardt). 3s.
 15249. **Dynamo-electric machines.** De Ferranti. 1s. 1d.
 16249. **Electric light switch.** Lundberg. 8d.
 18108. **Casings for electric cut-outs.** Lake (Bergmann). 6d.
 18233. **Duplex electric telegraphs.** Taylor. 8d.

1889.

11341. **Electric meters.** Walker and Braeken. 8d.
 14333. **Incandescence lamp.** Arnold. 6d.
 14565. **Recording telegraph signs, &c.** Draper and Ash. 6d.
 14601. **Electric batteries.** Macaulay-Cruikshank (Barrett). 6d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name	Paid.	Price Wednes- day
12 Feb.	1/2	Anglo-American Brush E.L.	—	4½
12 Feb.	2/0	— fully paid	—	5½
14 Nov.	0/4½	Con Telephone & Main ...	1	4½
27 July	10/0	India Rubber, G. P. & Tel.	10	19½
.....	.....	House-to-House	4½	5
.....	.....	Metroptn Electric Supply	—	3½
.....	.....	London Electric Supply ...	5	4½
.....	.....	Swan United	3½	5
2 July	12/0	Telegraph Construction ...	12	43½
2 July	6/0	— 6%, 1889	100	105
... ..	...	National Telephone	5	6½

NOTES.

Bury.—The Bury County Council have passed a resolution to apply for powers to light the borough by electricity.

Brixton.—The plan for construction of a chimney shaft for the electric lighting station at Electric-avenue, Brixton, has been approved by the authorities.

Five-Wire System.—The system of distribution by five wires is to be introduced shortly at Trieste. A station at Vienna will also distribute on this system.

Richmond.—Statutory notice has been given by the Brush Electrical Engineering Company of their intention to apply for powers to supply electricity in Richmond, Surrey.

Konigsberg.—The Municipality of Konigsberg are installing a central electric station for 8,000 lamps upon the combined five-wire system of Messrs. Siemens, and the Tudor accumulators.

Society of Arts.—On Wednesday, November 27th, at 8 p.m., a paper will be read on "Scientific and Technical Instruction in Elementary Schools," by Dr. J. Hall Gladstone. Mr. A. J. Mundella, M.P., will preside.

Edinburgh Exhibition.—By an advertisement appearing elsewhere, it will be seen that the Executive Council of the Edinburgh Exhibition invite tenders for the lighting of the exhibition grounds and buildings.

Paper.—The next meeting of the Institution of Electrical Engineers will be held on Thursday next, 27th November, at 8 p.m., when a paper will be read on "Electrical Engineering in America," by G. L. Addenbrooke, associate.

St. Austell.—At the plucky little town of St. Austell, where electricity was so early adopted, the electric light has now been introduced into the Congregational chapel, and electricity is used as a motive power in working the organ.

Tender.—The Pump-room Committee of the Leamington Town Council have received tenders for putting in an installation and electric fittings to the new swimming-bath, and have accepted the tender of Messrs. Rooper and Tozer for £86.

Electric Farming.—The new order of things is beginning to show forth buds. At a model farm in Belgium, a small station for the transmission of power has been established, and the reapers and winnowers are now driven by means of a 10 h.p. motor.

Combination among Telegraph Clerks.—A committee meeting of the staff of the Central Telegraph Office was held last week, at which it was resolved to establish a "London Telegraph Clerks' Association," for the purpose of forwarding their interests as civil servants.

Germany.—In the German Empire there are now 15,631 telegraph stations. The telephone has made great progress in Germany. There are now over 200 towns possessing exchanges, with about 39,000 subscribers. Berlin alone has 11,200, and Hamburg 4,000 telephone subscribers.

Colliery Working.—At the invitation of Messrs. Immisch, a party of about 70 mining engineers and others visited the interesting installation of electric mining plant at the St. John's Collieries, Normanton, which has been working for 22 hours out of 24 every day for two years.

Wolverhampton.—The Wolverhampton Town Council have decided to apply to the Board of Trade for a provisional order enabling them to supply electricity for public and private purposes within the borough, and to oppose similar applications by two electric light companies.

Spanish Tramways.—The electric tramway of Bilbao, which has just been constructed by the Brush Company, will shortly begin running. A similar tramway at Portugalete, will also shortly be put to actual work. Tests of tramcars driven by accumulators are to be carried out at Madrid.

Brussels Tramway.—The concession for a new line of tramway has been applied for to the Brussels authorities. The line is to start from the Porte du Rivage following the Boulevard Leopold II. to Koelkelbergh Station, ending at Dielighem. The power employed will be some system of electric traction.

Monte Video.—A central station has lately been opened at Monte Video, by the Compania Nacional de Luz Electrica. The station, which will supply 15,000 lamps of 16 c.p., contains five Belleville boilers of 300 h.p., and eight engines of 150 h.p., driving direct the same number of Zipernowski alternate-current dynamos.

Paisley.—The Corporation of Paisley, who have recently decided to apply for a provisional order for supply of electric light, are possessors of their own gas works, and their engineer, Mr. George R. Hislop, is understood to be one of the few gas engineers who are believers in the policy of gas companies also supplying electric light.

Copper.—It is stated that Mr. George Westinghouse has extended his field of operations into the raw material by the purchase of a valuable copper mine in Arizona. The Westinghouse Company now use some thousands of tons of copper a year, and the saving of profits will amount to a very large sum yearly. The mine will employ about 300 men.

Electric Alarm for Druggists.—The occasional errors of chemists in making up drugs or prescriptions, has led to an ingenious application of electric alarms. It has been proposed to connect each stopper of the bottles containing poison to an electric circuit, so that whenever the chemist takes out the stopper of such a bottle an alarm bell will ring to call attention to the fact.

Electric Light for Looms.—Messrs. R. R. Buck and Co., weavers, Carlisle, have successfully fitted up their works at Wigton with the electric light, much to the satisfaction of the operatives. The light is clear and brilliant, and admirably adopted for power loom weaving. The work was completed under the careful superintendence of Mr. Campbell, of the firm of Messrs. Anderson, Campbell, and Munro, Glasgow.

French Telegraphs and Telephones.—In relation to our note last week with reference to modifications in the French telegraphic systems, it is announced that M. Coulon, the Director-General of French Posts and Telegraphs, and M. Berthon, the chief of the Telephone Department in Paris, have arrived in Berlin with a number of engineers in order to acquaint themselves with the system and working of these departments.

Tramways at Neuilly.—The steam tramcars are to be re-established at Neuilly, Paris. Some six years ago, owing to the danger and the inconvenience of noise and smoke they were suppressed and animal traction again tried.

Now, however, it appears from a note in *L'Electricien*, that the objectionable steam locomotives are to come back. Would it not be a good opportunity to press forward the many advantages of electric traction for the tramways at Neuilly?

Madrid.—A company has been formed under the name of La Compana Madrilenia de Electricidad, with a capital of 3,000,000 pesetas, for supply of electricity in Madrid. The directors include Sen. Moret, late minister, Sen. Lobo, director of the Spanish-German Bank at Madrid, and Messrs. Rathenau, Siemens, and Grinner, the latter three of Berlin. The plant is to be supplied by the Allgemeine Elektrizitats Gesellschaft, the head quarters being at the Madrid Bank.

Provisional Orders.—Lord Balfour of Burleigh, the Parliamentary Secretary of the Board of Trade, states that the Board have been overwhelmed this year with applications under the Electric Lighting Acts of 1882 and 1888 for provisional orders to sanction the production and supply of electric lighting in all parts of the United Kingdom. Already the number of applications has reached 430, and power to apply for further orders will remain open until the 30th instant.

Using the Exhibition Stations.—It appears from the report of M. Alphaud, director of works to the Municipal Council of Paris, that the city has purchased the Edison central station of the Paris Exhibition as it stands. This station is now to be run by the city, and will light the luminous fountains and the parks which will be established in place of the exhibition pavilions when these are removed. More plant will be added, and the underground distribution will be extended for this purpose.

The Council to pay.—A rather new departure in the treatment of electric mains was inaugurated at Chelmsford, where, on the recommendation of the Lighting Committee, the Council agreed that the electric wires crossing in front of the Shire Hall and across Tindal-square, should be placed underground instead of overhead, "the Council to pay the extra expense, estimated at £20." The resolution was carried, Alderman Duffield protesting that the breaking up of the ground for electric lighting purposes was wholly illegal.

Public Lighting of the Strand.—At the Strand District Local Board, it was decided that the Works Committee should be informed that no expenditure be made with regard to the gas lamps in the district, except what is absolutely necessary, till the electric lighting mains have all been laid, so that the Board may, if it think fit, adopt electricity as a means of lighting the district. The Electric Light Company had given notice of their intention to lay mains in Chancery-lane, Carey-street, James-street, and Russell-street.

Electro Harmonic Society.—The next concert of this society will be a ladies' night, to take place on Friday, November 29th, 1889, at the St. James's Hall Restaurant (Banquet-room), Regent-street, W., at 8 o'clock. The artistes will be: Miss Ada Patterson, Miss Hannah Jones, Mr. Arthur Thompson, Mr. F. C. Cozens, Mr. Robert Hilton. At the piano, Mr. Alfred Izard. Besides a full programme of songs, recitations will also be given, and a thoroughly enjoyable evening, graced by the presence of the ladies, may be expected.

C. & C. Electric Ventilating Motors.—All the motors exhibited by Messrs. Shippey Brothers, Limited, at

the Birmingham Exhibition were sold. One has been fixed at a brewery at Burton-on-Trent, one for ventilating a bank in Yorkshire, two for ventilating the smoke-rooms at an hotel at Manchester, and four for various other electrical circuits in Bradford, Leeds, Liverpool, and Birmingham. Ten of the C. & C. fan sets have also been fitted in the new s.s. "Teutonic," for ventilating the saloons, kitchen, smoke-rooms, etc., for the White Star Line.

Electric Grapes.—Messrs. Campe and Co., the glass manufacturers of Berlin, have recently, owing to the great extension of electric lighting in that city, been devoting themselves to many varied and artistic forms of glass shades. They have introduced quite a fashion in one form of globe, which is formed on the exterior like a bunch of grapes and hangs from a vine branch, the inside of course containing the electric lamp. For conservatories and similar situations the idea evidently will commend itself to those who aspire to harmonious and novel effects of decorative lighting in private houses.

High-Pressure Dynamos.—The spirited lead of Ferranti in the matter of high voltages for dynamos seems to be resulting in other makers turning out high-voltage machines. The Tivoli installation, which is being carried out by Messrs. Ganz and Co., of Buda-Pesth, will have six alternating dynamos of 5,100 volts pressure, and giving 45 amperes each. Three low-tension dynamos, of 180 volts and 150 amperes, are also employed, the whole plant being driven by six Girard turbines of 350 h.p. each for the high-pressure machines, and three of 50 h.p. for the low-tension machines. The installation will doubtless prove an interesting one to electrical engineers.

Pekin.—The Westinghouse Company, of Pittsburgh, has completed negotiations with the representatives of Pekin, China, for a large electric lighting plant for that city, and the entire plant has already been shipped, and will be erected immediately upon its arrival. The contract is stated to have been the subject of lively competition on the part of European manufacturers, and the Westinghouse Company are elate over their success, which may not unnaturally lead to further supplies of electric machinery to the Celestials. It is stated that Mr. Byllesby, vice-president of the company, who lately arrived in London, may probably run over to China to see after business and to translate the electrical terms into Chinese.

Cost of Train Lighting.—The following figures were given by M.M. Sartiaux and Weissenbruch at the recent International Railway Congress: (1) The lighting of trains by accumulators recharged at fixed points costs in America, 2.5d. to 2.8d. per lamp hour of 12 to 16 c.p.; and in Europe, 0.95d. to 1.5d. per lamp hour of 6 to 8 c.p. (2) The experiments made in Europe have shown that it is possible to recharge accumulators by a dynamo driven by the locomotive: under these conditions the lamp hour of 5 c.p. costs 2.5d. (3) The lamp hour of 16 c.p. costs in America 2.25d. on an average, when the train carries in a special compartment a dynamo and steam-engine driven by steam from the locomotive. The lighting by colza oil costs 2.817d. per lamp hour of 5 to 6 c.p.

Ireland.—A meeting was held in Ballymena last week with the object of taking steps to establish a local electric light company. Mr. Camlin said that a memorial in favour of organising an electric light company had been signed by about sixty merchants and shopkeepers of the town, and that if even only this number took in the electric light, the contemplated new venture would be a paying speculation.

One of the parties who had signed the memorial, he said, had intimated that he was ready to invest in the new venture from £100 to £500. Mr. Rainey proposed, Mr. John Collins seconded, and it was carried unanimously: "That a committee be formed, with power to add to their number, to obtain all the necessary information concerning this contemplated new scheme." The committee were then selected.

Thunderstorms.—At the meeting of the Royal Meteorological Society on Wednesday evening, the second report of the Thunderstorm Committee was read. This is a discussion by Mr. Marriott on the distribution of days of thunderstorms over England and Wales during the 17 years 1871-87. Notices of sheet lightning are included in the term "thunderstorms." The years of greatest frequency were 1880, 1882, 1884, and 1872, and the years of least frequency 1887, 1874, 1879, and 1871; years of greater or less frequency alternate regularly throughout nearly the whole of the period. The average yearly number of thunderstorms is about 39. The districts with the greatest yearly frequency are the South of England and extreme northern counties, and those with the least yearly frequency are Cheshire, Lancashire, and Yorkshire. The greatest number of thunderstorms occur in July, and the least in February and December.

Blackburn.—A special meeting of the Blackburn Town Council is called for Thursday, December 5, at which the business proposed to be transacted will be as follows: To take into consideration the propriety of applying to the Board of Trade for a provisional order authorising the Corporation to erect and maintain electric lines and works, and to supply electricity for public and private purposes within the borough, and to resolve, "That pursuant to the Electric Lighting Acts 1882 and 1888, application be made to the Board of Trade for a provisional order authorising the mayor, aldermen, and burgesses of the borough of Blackburn to erect and maintain electric lines and works, and to supply electricity for public and private purposes within the borough of Blackburn, and that the town clerk be authorised to take steps and proceedings necessary for the purposes of such application and the promotion of the order."

Central London Railway.—An advertisement, a column long, appears this week in the daily papers, giving statutory notice of the intention of a company to apply for powers to construct underground railways in London, and to run them by electricity or motive power other than steam locomotives, and to make arrangements with the Southwark Subway and other companies—all of which will remind the public that the delectable scheme of joining the City with Shepherd's Bush and the fair far West is in the way for practical realisation. According to this notice three railways are contemplated: No. 1, from Paddington to Oxford-street, No. 2, commencing by a junction with No. 1 to King William-street, City, and No. 3 commencing by a junction with No. 2 and terminating by junctions to the City of London and Southwark Subway Company. The gauge is to be the usual railway gauge. Plans and sections will be deposited for public inspection on or before 30th inst., at the Sessions House, Clerkenwell, and the Sessions House, Old Bailey, and also, of so much as relates to the various parishes, at their respective vestry halls.

County Council Regulations.—At the County Council meeting last week, the subject of electric light

mains and subways was brought forward. Mr. A. H. Haggis (chairman of the Highways Committee) reported that the committee were preparing a code of regulations, which they would shortly submit to the Council for approval, with respect to the use by companies and others of the subways vested in the Council; and in these circumstances the committee recommended that the Council do sanction the laying of the Metropolitan Electric Supply Company's mains in the subways in Shaftesbury-avenue and Charing cross-road, in accordance with the notice, dated Oct. 16, 1889, and the plans submitted therewith, upon the following conditions: That the mains be laid in iron pipes as shown by alternative No. 3 on the tracing submitted by the company; that the positions to be occupied by the mains in the subways be subject to the approval of the engineer of the Council, and that the work of placing the mains be carried out to his satisfaction; and further, that the company before commencing to place its mains in the subways, do give an undertaking under seal, to be prepared by the solicitor, to pay such an annual amount for rent as may be settled by agreement, or, in the case of difference, by arbitration. The recommendation was adopted.

Electric Turn Table.—Details are given by the New York *Electrical Review* of the electric transfer table, in the new repairing shops of the Fitchburg Railroad, at Fitchburg, worked by the Union Electric Car Company's system. The motor is geared to the front axle, and the gears run in an enclosed bath of oil. They are brass cut gears, and work with the least possible friction. The switch which governs the motor and controls the car is just above the motor, on a platform built out from the front of the car, as are also the reversing bar and the handle, throwing in and out the clutch by which the motor is used either to propel the car in the desired direction, or to draw off and on the railway cars to be changed from one track to another. The two shops are each 500ft. long, and face each other. Each shop is divided into three divisions, separated by brick walls. In each division there are eight tracks, making 24 in each shop. Between these shops, which are 75ft. apart, is the pit in which the transfer table moves. The car is 10ft. long and 70ft. wide, and runs on four rails laid in the pit. The table is run by the dynamo which lights the shops at night, and is connected by two overhead wires, on which run two trolleys, the trolley-poles being on the top of the house built over the front platform at the front of the table. Three men, one being at the dynamo, now run the table and draw on and off the railway cars.

Electricity and Engineering Trades.—A very pregnant remark upon a subject which others have also well recognised was made by Mr. Ebenezer Kemp in his presidential address to the Institution of Engineers and Shipbuilders in Scotland. Mr. Kemp took for his subject the present age as pre-eminently the age of great undertakings. He described the Eiffel Tower, the Palace of Machines, the Forth Bridge, the Manchester Ship Canal; he alluded to the coming Channel Tunnel or Channel Bridge; and as one of the most wonderful among gigantic undertakings he mentioned the Deptford Electric Station. "Even marine engineers," said Mr. Kemp, alluding to the horse-power required, "who have been accustomed to consider the machinery they had to deal with as the largest for any purpose, will now have to take a back seat. The shafts of the dynamo require an ingot of 80 tons from which to forge them, and have a diameter of 36 inches on the middle portion when the dynamos are fitted. The indicated

horse-power which is being provided to drive these dynamos is quite unprecedented. The amount required for the buildings being erected at present is 43,000 h.p., and space is acquired for the erection of buildings for an additional 80,000 h.p., making a total of 123,000 i.h.p. In view of these facts it is difficult to imagine what will be the future of electricity; but if electric lighting becomes to any extent general, in the near future a great prosperity is in store for the engineering trades of the country."

Glasgow Students' Appointments.—It is rather satisfactory to note the positions held at the present time by students turned out under Prof. Jamieson, at the Glasgow and West of Scotland Technical College. Lately we have mentioned several, and among some others are the present resident engineer at Barnet, who is just laying down the new Heisler plant there, Mr. Gerald St. J. Day, who had charge of the practical working of Messrs. King, Brown, and Co.'s lighting station at last year's Glasgow Exhibition, and then was for some time with Messrs. Rashleigh, Phipps, and Dawson; and Mr. Guy Hamilton, who had charge of the laying down of the plant at the small station in Crieff. This station, it will be remembered, was carried out by Mr. C. H. Yeaman, who lately left the Ward Electric Car Company to take up the Liverpool electric inspectorship, and is now with Messrs. Anderson and Munro, of Glasgow, busy getting the practical working of the testing clauses of the Liverpool Electric Lighting Order into shape. This gentleman is also a Glasgow student, and it is interesting to note that the only holder of the medal for the Science and Arts Honours Examination in Testing has been appointed the first Electrical Inspector under the new regulations. Prof. Jamieson has achieved the feat of turning an institution, which was originally little more than a secondary school, into a high-class technical college, whose effect in training thorough students is very widely felt, and it now holds, we believe, the proud position of having obtained by its students in the same time more Whitworth Scholarships than any other technical institution.

The Gilbert Club.—A correspondent writes: Under this title an association is being formed for the special purpose of bringing out an English edition of Dr. William Gilbert's famous work "De Magnete," as nearly as possible in imitation of the fine folio edition of A.D. 1600; and to arrange for the Gilbert tercentenary in the year 1900, for which the club will furnish an organisation, but of which it will not necessarily attempt to bear the cost. The publication of "De Magnete" not only marked an epoch in the science of magnetism, but constituted the absolute starting-point of the science of electricity. It has been hitherto a reproach to British electricians that they too little recognised the merits of the founder of the science. Dr. William Gilbert not only enjoyed the distinction of being physician to Queen Elizabeth and to James I., but was also president of the Royal College of Physicians. His researches on the magnet brought him into correspondence with all the learned men of Europe. He was, indeed, practising the experimental method of investigation before Bacon wrote about it, and his method and discoveries excited not only the sneers of Bacon, but the praises of Galileo and Kepler, and of many great men of later date. No English translation of this great work has yet appeared. Only a limited number of invitations is being issued to join the club, and among those who have already consented to become members are Sir William Thomson, Lord Rayleigh, Mr. Jonathan Hutchinson, Prof. Tyndall, Sir John Lubbock,

Sir Douglas Galton, Sir David Salomons, Prof. Reinold, Prof. Rücker, Mr. Latimer Clark, Mr. W. H. Preece, and Prof. G. Forbes. The first meeting of the club will be held on November 28 at the Society of Arts.—*Times*.

Electric Lighting of the Czar's Train.—M. Werchowsky, engineer and general inspector of the Russian railways, gives a description of the somewhat extensive electric lighting of the Imperial train which was adopted after preliminary experiments with a part of the train only. The firm of Jablochkoff and Co., of St. Petersburg, constructed and fitted the incandescent lamps, which are of 6 to 8 c.p. at 30 volts, the conductors arranged with contacts between the carriages, the accumulators disposed in three groups, the apparatus for charging these accumulators, the voltmeters and ammeters, and also the dynamo. The steam-engine driving the dynamo is a Brotherhood three-cylinder machine. The boiler, horizontal, with iron firebox and tubes, were made by Messrs. Nobel, St. Petersburg. The dynamo, steam-engine, boiler, the battery of 36 accumulators, and the reservoir of water, are fitted in the middle compartment of a wagon with four partitions, specially constructed for the purpose. The other compartments, containing the fittings and oil, the fire-pumps, the Graftio apparatus for controlling the speed of the train, and, lastly, a Schwarzkopf apparatus for prevention of explosion of the boiler. The Imperial train consists in all of fifteen carriages. The total number of lamps employed is 253, and they are disposed as follows: electric wagon 6, workshop wagon 8, the Minister of Internal Communications 22, the Czar's servants 15, kitchen-wagon 13, buffet-wagon 13, dining-room car 26, Czarina's car 18, Imperial car 36, Grand Duke 20, ladies-in-waiting 21, Ministers' car 21, officers of the suite 21, body guard 13, luggage 7. All the incandescent lamps can be turned on or off separately by the aid of two cords, one red, the other black. Another battery of 18 accumulators, is placed in the buffet-wagon, enclosed in a wood box; a third battery of the same number of cells is placed in the dining-room car. The accumulators are charged by the main current from the dynamo. The engine is capable of working at 15 h.p., but works usually at about 12 h.p. In the carriages the lamps are distributed singly and in groups. The lamps are either obscured or fitted with ground glass shades, and in the Imperial car movable fittings are used. When the whole of the train was completely fitted, the authorities made two thorough tests: first, the train when standing was lighted for twenty-four hours; secondly, the train was completely lighted during the journey from St. Petersburg to Moscow (400 miles), at an average speed of 35 miles an hour, at Moscow during a stoppage of ten hours, and throughout the return journey to St. Petersburg. During the last test, the dynamo was stopped for about two hours, and the accumulators completely charged were then used alone. The Imperial train during the journeyings of the Czar in 1888 ran a distance of more than 5,000 miles, and the electric light always worked well. The train was partially wrecked in the catastrophe of 17 (29) October, 1888, but the wagon on which was this rolling electric central station, which followed next to the tender of the second locomotive, was practically uninjured.

A University Faculty of Engineering.—Mr. Henry Dyer, C.E., M.A., life-governor of the Glasgow and West of Scotland Technical College, has a very careful and thoughtful paper upon what may be termed the science of teaching engineering in the *Transactions* of the Institution of Engineers in Scotland just published, which

those who are working and agitating for extended scope in technical teaching might do well to peruse. In this paper Mr. Dyer puts forward a plea for a university Faculty of Engineering, to be recognised as fully as arts or medicine. He points out the growing importance to communities of men with a thoroughly competent knowledge of engineering in all branches—civil, sanitary, electrical (a point we have lately had brought before us by the difficulty in choosing a suitable engineer for the London County Council). The French name of *ingénieur des ponts et chaussées* is very descriptive of the actual work, though perhaps too narrow. The engineer must be trained in allied branches: the civil engineer requires a knowledge of machines, and the electrical engineer without mechanical construction is confined to the least important parts of his subject. All engineers should have a knowledge of mathematics and physics, not necessarily such as would secure success in "such phantoms as mathematical tripos or honour lists," but a real knowledge which would fit them to solve problems they met with in ordinary life. A knowledge of French and German, or both, is important, and general subjects as literature or history would enable them to rise out of the narrow grooves of professional interests. Mr. Dyer gives a list of studies, remarking that the principles taught in lecture or drawing office should relate to problems of everyday practice, and not be, as now too often the case, mere mathematical puzzles. The problems should be worked out both by analytic and graphic methods, and the drawings made under conditions similar to those which exist in an engineer's office. Electrical engineering, Mr. Dyer remarks in the course of his paper, is almost the only department of engineering in Glasgow which is fairly well supplied with laboratory work, but there is much room for a co-ordination with allied subjects, such as mechanical engineering. He considers, however, that Glasgow, the greatest engineering centre in the world, is yet far behind some of the provincial towns of England and Scotland in technical training, and trusts this unsatisfactory state has only to be pointed out to be remedied. Mr. Dyer has much to say on examinations, but one point he always clearly insists upon—that is, that the conditions be as near as possible such as they would be in a real office. For a final examination, work should be given the students to do, together with such data, sketches, and figures as are necessary. They should be asked to explain the theories, make the drawings and specifications, and write a thesis on a subject connected therewith. Such an examination has been carried out successfully in the Imperial College of Japan, and would be equally satisfactory in our own colleges. Mr. Dyer agrees with Sir Benjamin Browne upon the retention of apprentices in the workshop rather than their attempted training in college workshops, which he thinks the least useful part of a college, and mentions that Sir Benjamin Browne's firm (Hathorn, Leslie, and Co.) are in the habit of paying the fees of every apprentice who attends approved evening classes—an example much to be imitated.

Leamington.—The Watch Committee at the last meeting of the Leamington Town Council recommended that the contract with the Midland Electric Light Company be continued quarter by quarter, and also that the borough surveyor be instructed to insist upon the cleaning of the lanterns and the renewal of lamps when these become deteriorated. The town clerk had drawn up a report upon the question of electric lighting, which he then read as follows: As requested, I have had an interview

with Messrs. Chamberlain and Hookham with reference to their contract for the supply of electric light to the public lamps, and which by virtue of notice served expires on the 17th January, 1890, and they have agreed, if it is the wish of the Council, to continue the present system beyond that period. They will supply the existing light on the terms of the existing contract, to be determined by three months' notice by either party on the usual quarter days—in all other respects the conditions of the contract to remain in force. I had a long discussion with them as to improving the present light, and they considered it quite equal to the power provided for in their contract, and greater power could not be given except at an increased cost. If their tenure was not of such a precarious nature they would suggest that a lesser number of lights should be used, and greater power given to those remaining, which system they say would improve the appearance of the lighting. I also urged upon them the necessity of cleaning the lanterns more frequently, and renewing the lamps when decreasing in strength of light, but they very candidly admitted that as their contract was running out they did not renew the lamps more frequently than they could avoid. If the present system is to be continued, these two points should be closely attended to, which would materially improve the light. I also discussed with them the question as to the lighting the Parade with the Thomson-Houston arc light. They said it would require at least 25 lights, at a cost of £500 per annum, but the inseparable objection to this system appears to be that these lights will not burn more than eight hours at a time and would require renewal. To adopt this system and to make it a success duplicate lights would be required, so that when the first 25 were burnt out the others could be turned on, but for a later period of the evening only a few lights would be required, or the electric light could be discontinued about 11 o'clock, and a few lights substituted sufficient for all police purposes in looking after the town. I afterwards visited the Electrical Exhibition at Birmingham, and was astonished to see what a very small engine power was employed (only three engines) to work the dynamos which supplied the whole of the electric current for various systems used throughout the hall for lighting, and as a motive power in working machinery for printing, pen making, sawing timber, etc., as well as a tram line for propelling four carriages and eight people round a portion of the hall. I noticed that a small Robey engine was working the two dynamos of the Thomson-Houston system, and I was informed by a scientific electrician I met there that each dynamo could supply 80 arc lights, and that they might be supplied at a much lower price than named in this report; but unless the difficulty as to the time of burning can be got over, I cannot see how the system of arc lighting is to be generally used in the streets. The Mayor said the Council had heard the clerk's report, which showed that he had paid attention to the matter. He suggested that the report should be referred to the Watch Committee. Councillor Orton asked if there was anything to prevent the completion of the lighting of Regent-street, irrespective of the lighting of the Parade. Councillor Hodkisson called attention to the inefficient lighting of High-street, from the railway bridges to the Warneford Hospital. That he considered was one of the worst lighted parts of the borough. The report of the town clerk was referred to the Watch Committee, and the committee's report was adopted.

SOME PECULIARITIES OF ALTERNATE CURRENTS.*

BY W. E. SUMPNER, D.Sc.

Alternating currents are not by any means new, although it is only lately that they have become of great importance in engineering work. The first dynamos made yielded alternating currents, because, as they needed no commutator, they were simpler to construct. They were not adopted partly because continuous currents were easier to understand and to use, and partly because direct-current dynamos could be made self-exciting. Alternators came to be looked upon as antique types which had yielded place to the more perfect direct-current machine. However, the currents used outside the dynamo, although direct, were of course the result of rectifying by means of a commutator the alternating currents produced in the armature by its own revolutions. All dynamos, therefore, produce alternating currents in the first instance, and in the same way all motors, before they will work at all, must be fed with alternating currents, whether a revolving commutator is introduced to produce these alternations or not.

The action of all machines used for the production of currents depends on the properties of magnetic changes discovered by Faraday. The currents induced depend on the rate at which the magnetism varies and alter in direction as it increases or diminishes. The magnetism cannot continuously either increase or diminish, so that the currents induced must be alternating. Nearly all the useful appliances of magnetism result not so much from magnetism itself as from the alteration of it. This is the case, for instance, in telegraphy and telephony, in which we are always using varying or alternate currents. If I pass an alternating current through one of the coils of this transformer it begins to sing. The current in the coil induces magnetism in the iron which changes in direction every time the current alternates. The magnetism acts on the windings of the coil causing attractions, which vary in amount with the strength of the current; and it also causes in the iron itself stresses and strains which alter at every reversal of the current. Vibrations are therefore set up which give rise to a note of pitch corresponding with the frequency of the current. If, due to irregularities of driving, or want of symmetry in the dynamo, the strength or frequency of the current is subject to variation, the note given out by the transformer will indicate this by altering its strength or pitch. The consequence is, that the sound given out is very similar to the hum of the engine and dynamo. The transformer acts like a telephone, and, in principle, a telephone is nothing more.

The first difficulty in connection with alternating currents is to settle how to measure them. They are continually varying, and, therefore, cannot be said to have any value in particular. If I pass the varying current produced by this commutator through an incandescent lamp, you notice that when I turn the handle slowly the lamp varies in brightness according to the strength of the current passing. If, however, I turn the handle quickly, so as to produce 20 or more alternations per second, the lamp burns steadily. The strength of the direct current which would make the lamp burn equally well, is said to be the mean value of the alternating current. This definition seems simple enough, but it defines the value of a current with reference to its heating effect only. It is soon realised that the importance of an alternating current depends chiefly on its magnetic influences, and not to any great extent on its heating effect. With steady currents the two are proportional, and each therefore, is a measure of the other. Partly owing to this cause, and partly due to the false notion that the current carries energy along with it, we are liable to confuse the heating effect of a current, which represents waste energy, with the useful energy of the current, which has no necessary connection with it, and in consequence some of the properties of alternating currents seem at first surprising. The efficiency and life of lamps seems to depend merely on the mean heating effect, for, as far as we know, they are the same for direct and alternating currents, although with the latter the maximum value of the current is far in excess of its mean value.

With most of the practical applications of alternating currents, however, we have to bear in mind, not only the strength of the currents, but also their frequency and magnetic surroundings. The currents and potentials are continually rising and falling in value. They are really waves, and have all the properties of waves.

Now one of the chief peculiarities about waves is that they do not add together in the same way that numbers do. They add together like forces. We all know that if two forces, each of 1 lb., are acting on a body, the effect is not the same as that of 2 lb. unless the two forces are in the same direction. According to the angle between the forces, the resultant may vary from 2 lb. to nothing. If two men are pulling at the same rope in order to ring a church bell, it is necessary for them to pull together, or one will tend to stop the bell while the other tends to ring it. In the same way, two waves flowing to the same point will add to each other's effect if their rising and falling occur at the same time, but otherwise they will interfere and diminish each other's effect, so that the resultant disturbance may be less than that which either would have caused separately. It does not therefore follow that two alternating currents flowing into the same wire will produce a current whose strength is the sum of the strengths of the two components, and, as Lord Rayleigh* has pointed out, if a current branches into two currents, it may happen that each of the branch currents is stronger than the original current.

I have here the primary and secondary circuits of a Mordey transformer connected in parallel in such a way that, if steady currents were flowing, the coils would magnetise the iron in the same direction. In the main circuit and also in one of the branch circuits I have a Bernstein lamp. When I close the circuit you notice one lamp is much brighter than the other, and the bright lamp is in the branch circuit, not in the main circuit. The currents, as a matter of fact, are about four amperes in the main circuit and four and eight amperes in the branch circuits. If I now disconnect one of the branch circuits the current diminishes to practically nothing, although the potential on remaining coil actually increases. Shunting one coil with the other, therefore, not only increases the main current, but also that in the part shunted. These effects never happen with steady currents.

A somewhat similar experiment is due to Mr. Blakesley. His branch circuits consist, one of a resistance possessing self-induction, and the other of a condenser. By suitably choosing the capacity of the condenser, it is possible to increase the current through the self-induction branch and make it exceed the current in the main circuit.

The following experiment analogous to Lord Rayleigh's, but with potentials instead of currents, is due to Mr. E. W. Smith,† of the Central Institution. I have here a coil having a fairly large amount of self-induction in series with a resistance. I have two equal lamps of large resistance shunted, one to the inductive, the other to the non-inductive resistance. I pass the alternating current, and adjust the resistance till the lamps are equally bright. Each lamp now measures the difference in potential of the points to which it is shunted. I now remove the wire which connects the junction of the two lamps with the junction of the inductive and non-inductive portions. You notice that each lamp diminishes in brightness, showing that the whole potential difference is less than the sum of the two halves. By making the shunt connection again each lamp brightens up, although experiment shows, and theory confirms the fact, that the alternating current coming from the dynamo is diminished by so doing. By making the shunt connection we necessarily diminish the resistance, although the potentials appear to increase and the main current to diminish, the opposite of what would occur with steady currents.

I have extended this experiment by forming a Wheatstone bridge, two opposite arms of which consist of two inductive resistances, the remaining arms being non-inductive. To each corner of the bridge I have attached a flexible lead coming to these lamps. The two wires attached to the dynamo corners of the bridge I have labelled red, and the remaining two white. I connect the

* Presidential address to the City Guilds Old Students' Association read at the Central Institution, Nov. 19th, 1889.

* See *Phil. Mag.*, May, 1886, p. 378, and also Dec., 1885, p. 495.
† See *Phil. Mag.*, July, 1889.

red wires to the terminals of the two lamps and join their junction successively to the white wires, adjusting the non-inductive arm until the lamps are equally bright. Each time I make connection with the white wire the lamps brighten up as before. From analogy with steady currents, we should now expect the bridge to be balanced, since the potential difference between either red and either white wire is the same. If, however, we join the white wires to the terminals of the lamps, we notice they burn almost as brightly as when joined to the red wires connected directly with the dynamo. Theory indicates that if the impedance of the inductive arm were large compared with its resistance, the potential between the white wires would be exactly equal to that between the red ones, and that in any case, if the bridge is balanced in the way described, there will be a difference in phase between the two potentials corresponding with a quarter of a period, so that one potential difference will reach its maximum value when the other is at zero. Now this is exactly the difference in phase required to drive a Tesla motor. I have here a small ring of iron wound with coils in four quadrants. The coils in opposite quadrants are connected in series, so that a steady current flowing through either pair will cause a north and south pole in the adjacent quadrants. If, now, alternating currents differing in phase by a quarter of a period be sent through the two coils, each pole will move from one quadrant to the next every quarter of a period, so that the polarity will revolve round the ring with the same frequency as that of the alternating current. There is an iron disc free to revolve about the axis of the ring, and when I connect the red wires with one pair of coils and the white wires with the other you see the disc spins round at a great speed, and thus forms a Tesla motor. There is, however, this peculiarity about it, that only one alternating current is used. The disadvantage of a Tesla motor is that it requires two alternating currents fixed in phase with reference to each other, so that it is necessary to have a special dynamo to produce the currents and also to have at least three leads instead of two. Here, however, is a method of making any alternate current work a Tesla motor. Mr. Blakesley* has, I find, already suggested his condenser transformer for the same purpose. The method I have suggested is not economical, but it can be improved by having the arms of the bridge of high resistance or impedance, and having two opposite quadrants of the Tesla field-magnets wound with many turns of fine wire instead of a few turns of thick wire. Moreover, if condensers of suitable capacity are substituted for the non-inductive arms of the bridge, the waste will be smaller, and the amplitude of the potential between the white wires will actually be greater than that between the red ones attached to the dynamo. At all events there seems to be fair ground for supposing that some such arrangement can be found by means of which a Tesla motor can be economically worked off any alternating current.

Striking effects of interference are obtained by putting a coil, whose impedance is large compared with its resistance, in series with a condenser of suitable capacity. If an alternating current is passed through such an arrangement, and measurements are made with a quadrant electrometer used idiostatically, the potentials at the terminals of the coil or condenser are each found to far exceed the potential at the ends of the combination. Theory indicates that, under the most favourable conditions, the two former are equal to each other, and the ratio of either to the latter is then approximately equal to the ratio of the impedance of the coil to its resistance when this ratio is large. Thus, with the secondary of an induction coil having a resistance of 6000 ohms, and coefficient of self-induction 50 secohms (or quadrants), and with a condenser of $\frac{1}{10}$ microfarad capacity, calculation shows that the most favourable frequency of current to employ would be 98 periods per second, and that the potentials on the coil and condenser would each be about five times the potential on the two in series. In the confirmation of this by actual experiment, I have had the advantage of the assistance of Messrs. Monckton, Simon, and Taylor, of the Central Institution.

* See the discussion on Mr. Kapp's paper on "Alternate-Current Machinery," *Proc., Inst. Civil Engineers*, February, 1889.

The field-magnets of an alternator were excited with suitable currents so as to produce at various speeds of the dynamo an alternating potential of about 30 volts. In the table annexed the number of periods per second corresponding with the speed of the dynamo is indicated in the first column. The second column gives the ratio of the potential on the induction-coil to that of the dynamo, and of course is equal to the square root of the ratio of the corresponding deflections. The third column gives the ratio of the potential on the condenser to that of the dynamo. The last column gives the sum of these two ratios which, but for interference, would always be unity.

Periods per second.	Potential on coil.	Potential on condenser.	Sum of potentia
73	1.00	1.93	2.93
82.5	1.84	2.64	4.48
102	4.38	4.14	8.52
116	3.28	2.49	5.77
120	2.91	2.06	4.97

From these numbers it is evident that the potentials of the coil and condenser will be equal when the frequency is a little less than 100 periods per second, and the sum of the potentials will then be greater than 8.5 times the potential of the dynamo. When it is considered that the self-induction of the coil (which had an iron core) was measured, not with rapidly alternating currents, but with a single impulsive change of current, the agreement between the theory and experiment is quite satisfactory. But although theory so perfectly accounts for the effects, it is, nevertheless, surprising that an alternating difference of potential can be divided into two parts, each more than four times itself.

What is really happening in these cases of interference is illustrated by an experiment on pulsations, which I am able to perform by means of an ingeniously contrived commutator, kindly lent me by Mr. H. B. Bourne. Alternate bars of the commutator are connected together and to the two ends of a battery of cells. There are two brushes, one fixed and the other movable, so that as the commutator revolves, one brush may be made to move over the bars more rapidly than the other. Each of these brushes is connected with the middle of the battery through the primary of a transformer. The two secondaries are connected together through an incandescent lamp. The brightness of the lamp measures the sum of the two currents induced in the secondaries by the alternating currents in the primaries. If the brushes are both fixed, the phase of the currents is fixed. If the currents coincide in phase, the lamp burns brightly; while if the phase of the currents is opposite, as I can arrange by suitably placing the movable brush, the lamp is extinguished. If I now revolve the movable brush slowly, the phase of the currents is continually altering, and you see the lamp pulsating in brightness. Although the two alternating currents are always of the same strength, yet their sum varies from zero to double the value of each, according to the phase of one with respect to the other.

After all, however, the most extraordinary property of alternating currents is that which has been longest known, viz., their tendency to transfer themselves from one circuit to another with which they have apparently no connection. The appearance of these induced currents is accompanied, not by a decrease, but by an increase of the primary current. The primary and secondary currents increase together. The explanation is that the currents are in nearly opposite phase, and one current is neutralising the magnetising effect of the other. The magnetism caused by alternating currents always tends to a minimum, and the currents have to arrange themselves so that their joint magnetising effect may be as little as possible. This tendency is very marked at high speeds, and the compensation is almost perfect. The little magnetism remaining is, however, very important, because of its extremely rapid rate of variation. The induced E.M.F.'s depend on this rate of variation, and not on the maximum amount of magnetism. Thus, in transformers, there is a strong tendency for the primary and secondary currents to be in opposite phase.

[This is the explanation of a simple but important experiment due to Mr. Mordey, and the fact was proved by a large number of experiments of Messrs. Lamb and E. W. Smith, made at this college some time ago.*] The strengths of the currents in the coils also arrange themselves to be nearly inversely proportional to the number of turns, for this is the condition that the magnetising effects should be equal. There is also a tendency for the magnetism to alter itself in the simplest way possible, and this is according to the law of sines. The secondary currents, therefore, tend to follow the law of sines because they exactly follow the variations of the magnetism. The primary current will also follow the law of sines if the magnetism is proportional to the current; but if saturation is approached, calculations I have made from experimental data show that the primary current may depart very much from a simple sine wave, as will also be the case if the E.M.F. acting on the primary is itself irregular.

The tendency of magnetic change to a minimum, is exemplified in the action of choking coils and in the heating of iron cores. If an opposite current can be induced in neighbouring circuits or bodies, so as to cancel the magnetising effect, the primary current is allowed to flow, but otherwise the reluctance of the magnetism to change suddenly will prevent the current rising to any magnitude.

The same tendency occurs within the wire itself, for the adjacent portions of the current tend to flow in opposite directions. The tendency to reverse currents is strongest in the centre of the wire, and consequently the current density is less there than near the surface. The resistance of the conductor is increased by this, and the alternations of the current are very frequent, as, for instance, in the thick wire circuit of electric welders. Thick leads are, therefore, not well suited to alternating currents, but, on the other hand, they are rarely necessary, for, by means of transformers, large amounts of energy can be efficiently transmitted immense distances by means of inexpensive thin wires.

It is not, however, only in engineering practice that alternating currents have become of great importance. Within the last year or so the theory of electricity has been advanced tremendously by the study of alternating currents. We have seen that with rapid alternations the currents are determined chiefly by the magnetic changes which are going on, and that they arrange themselves so as to neutralise each other's magnetising effect, and without much apparent regard to the E.M.F.'s acting, or the resistances in circuit. This tends to show that the most important part of a current is not in the wire itself, but in the region outside it. It has been by considering the changes going on in the medium outside the wire that Hertz has been able to prove the existence of effects which have hitherto only had a mathematical basis. If a current is reversed in direction, the lines of force surrounding it are also reversed. Maxwell's theory, however, states that they do not reverse instantly. The lines of force near the wire reverse before the others. There is a certain velocity at which the reversal of the lines travels, and this velocity, according to theory, should be the same as the velocity of light. That this is actually the case is one of the things that Hertz has lately shown. In order to do so he has made use of very rapidly alternating currents. He has also employed a detector whose great delicacy is due to the principle of resonance, which may be illustrated by an experiment of Prof. Ayrton's† which I have arranged. An alternating current is passing along this stretched wire. When I hold a magnet near, the wire is pulled aside, owing to the mutual action of the current and the lines of force and of the magnet. Every time the current reverses, the direction of the pull on the wire reverses, so that the wire is put into a state of vibration. The loudness of the sound, however, depends on the length of the stretched portion of the wire. There is one length which will give the best effect, and

this happens when the wire is tuned to give out a note of the same pitch as that corresponding with the frequency of the alternating current. The current forces the wire to give out a particular note, but if the wire naturally gives out that note the sound produced is much greater. The interference of potentials occurring when an induction-coil is placed in series with a condenser is another instance of resonance, for the condition that the potential on the coil should be greatest compared with the whole potential acting on coil and condenser can also be shown to be the condition that the natural period of oscillatory discharge of the condenser into the induction-coil coincides with the period of the alternating current. It has been by using this principle of resonance that Hertz has been enabled to detect in the medium outside the wire cases of interference with magnetic reversals exactly similar to those I have shown you with alternating currents and potentials. His work has opened up an endless field of discovery, and these results have been brought about by making use of the peculiarities of alternating currents.

NEW YORK NOTES.

(FROM OUR SPECIAL CORRESPONDENT.)

*The "Deadly Wires" at it again.
They Kill a Horse and Shock a Policeman.
Reporters' Gems.—Newspaper Sincerity.—An Editor's Confession.
The Technical Press and Mr. Edison's Views and Interviews.
Respectful Dissent.
New Western Union Cables.
Telegraph Rates.
The Latest thing in Train Electric Lighting.
Why the Car-Axle Method does not Work here.*

NEW YORK, November 8, 1889.

Another accident, caused by the electric light wires, occurred this week, and the daily papers have made the most of it. Early last Monday morning a telephone wire on Fourth-avenue broke and fell into the street. There are two sets of poles on Fourth-avenue, the higher ones carrying telegraph and telephone wires, and the lower electric light and power wires. The broken wire formed a cross with one of these, and lying across the street, was ready to make things lively for the first comer. This happened to be a horse drawing a *Herald* delivery cart. The horse stepped on the wire, and was knocked down by the shock and killed. The driver was thrown into the street, but although he received a shock on going to the horse's head to see what was the matter was not seriously hurt. Considerable excitement ensued; several policemen appeared on the scene, and one of them commenced to grope in the dark for the wire with his club, but succeeded in finding it with his head, receiving a shock which knocked him down. According to the reporters blue flames and sparks were flying around galore, and the wire "sizzled in a particularly dangerous way." One account of the accident in an evening paper was realistic in the extreme, and, as crowning evidence of the deadly character of the telephone wire, the reporter set forth at the end of his account this very remarkable statement: "Even after it was cut and pulled down from the pole, the wire blazed and sputtered in the gutter for half-an-hour." That reporter is a jewel.

A rather interesting light was recently thrown on the honesty of the views expressed by almost all the daily papers on the recent discussion about accidents due to electric light wires. The lay press generally have shown the most bitter animosity against the electric lighting companies, and have not hesitated to distort facts and exaggerate matters in the wildest manner in order to make out a good case against them. Dr. Van der Weyde, who is well known in electrical circles here, wrote an article pointing out the fallacy and absurdity of many statements publicly made, and sent it to the daily papers. The article was sent back, and one editor wrote a polite note to the author saying that he could not publish it as the article was in total opposition to the views advocated by him, as well as by the other daily papers; he added that he could not dispute the arguments set forth in the article as he considered them perfectly sound and correct, but that the daily papers had to be guided by the public feeling in the matter.

* See discussion on Mr. Kapp's paper on "Alternate-Current Transformers," *Journal Soc. Tel.-Eng.*, February 23, 1888; also a note of Profs. Ayrton and Perry on "The Lag in Transformers," in the *Electrician* for March 16, 1888.

† See Ayrton and Perry, "Notes on Alternate Currents," *Proc. Inst. Elec. Engineers*, March, 1889.

As a proof of sincerity, this editorial confession is certainly unique, and it is curious to learn that the papers publish only what they think the public like to hear about a subject whether it be true and accurate or exactly the reverse.

There has been a good deal of comment in the technical press on the endeavours of the Edison Company to turn the situation to their own advantage, and on Mr. Edison's press interviews, and *North American Review* diatribe against the alternating current, to which I referred last week. The curious point about these comments is their eminently respectful and gently deprecatory tone. That divinity which doth hedge in a successful inventor who has amassed a goodly share of this world's goods, and has become a potentate in the industry to which he has devoted himself, stands Mr. Edison in good stead in protecting him from the bitter denunciation with which his utterances would have met had they all been made, say, by a Brown or by a Heinrichs. In some cases Mr. Edison's views are respectfully dissented from, in others his name is not even mentioned, but the respectful dissension is there all the same. However, in however guarded and soft tones the note may have been uttered, it has been one of dissent all along the line, nobody (except perhaps the irrepressible Harold P., and he does not count) having seconded Mr. Edison's motion to abolish the high-tension alternating current, and it looks very much as if the motion would be lost.

Yesterday the "Faraday" laid the New York shore ends of the two new sections of the Western Union cables at Coney Island. Coming down from Canso the "Faraday" laid one of the deep-sea sections, and after having spliced this on to one of the shore ends will start laying from the other back to Canso. The landlines from the cable landing to Coney Island to the Western Union Company's offices in New York have already been completed, and the company expect to be through to Canso on both the new cables inside of a fortnight. The whole of the work, including the landlines at this end, has been carried out by Messrs. Siemens Bros. and Co.

With regard to the new rates for Government telegraph service, about which I wrote you last week, the rates are not considered just, but are naturally held to be a good deal better than Mr. Wanamaker's first proposition of one mill per word. The matter is occupying the attention of the executive committee of the Western Union Company, and it is reported that a long letter has been sent to the Postmaster-General about his proposal to submit the matter to arbitration. The letter will not be made public, but it is understood that the Western Union people are inclined to agree to arbitration, being confident that any commission would favour a just compensation for work done for the Government.

The electric lighting of the "Montezuma" special, a train of four improved Pullman vestibule cars shortly to begin running from Chicago through to the city of Mexico, appears to be the most complete train lighting installation yet carried out. Current is supplied from two sets of storage batteries placed underneath, and on each side of each car in the train. The new type of cell, Z3M, made by the Electrical Accumulator Company, of New York, is employed, and the cells are charged from an Eickemeyer dynamo driven by a Brotherhood engine. This plant is placed in one corner of the composite car, and includes an automatic lubricator holding two gallons of oil, steam-gauges, voltmeter, ammeter, and a tachometer. The Eickemeyer dynamo gives excellent results and requires very slight attention; a machine, now in service, has been running continuously for five months with an overload, and yet there has not been the slightest sparking at the brushes or trouble of any sort. The present machine gives 90 volts and 85 amperes at exactly 850 revolutions. The drawing-room car, the "Superb," which is a model of luxury, is fitted with 39 16-c.p. Edison lamps, arranged on two distinct circuits, termed the "end circuit" and the "body circuit," running directly from the cells to a switch and cut-out case placed in a convenient locker holding also the four safety strips. This arrangement permits of easy and economical handling of the all-night lights in the vestibule and toilet-rooms. Each lamp is also supplied with a key socket, so that a particular light may be turned

out by the occupant of a berth, while in the corner of each section silvered thimbles have been placed in which may be inserted a portable lamp with frosted bulb connected to the branch wires by means of a flexible silk cord, the terminals of which are inserted into sockets placed in a rosette above the section mirror, thus affording the desired angle of light should the passenger prefer to read while reclining. Mr. A. H. Bauer, the manager of the electric lighting department of the Pullman Company, has carried out the installation, and will probably accompany the "Montezuma" on her maiden trip. Mr. Bauer states that a thorough experience under various conditions has demonstrated the impossibility of securing even fair results in train lighting with the dynamo belted to the axle of the car, owing to the constant change in speed and the numerous curves found on American railways, round which the wheels will often slide without turning the axle a single revolution, thus playing the mischief with belt and armature. Mr. Bauer says he has seen such a method successfully employed on the London and South-Western Railway in England, and was impressed with the conditions tending to make the system a success, and which are widely different from those prevailing in this country, in the almost entire absence of curves and the high and constant speed maintained, made possible by the fact that that railway never crosses a country road at grade, being either above or below.

ELECTRICITY IN SOUTH YORKSHIRE.

The popularity of electricity increases and the demand for the electric light grows apace in unexpected and unlooked-for directions. In places where one would naturally expect gas and the products of coal to be more popular than anywhere else, the demand for the electric light is rising rapidly, and it is being brought into use at a great rate, enquiry respecting it having been quickened of late in a marked manner. Halifax, Dewsbury, Bradford, Leeds are, and have been, enquiring into and using the electric light, and now at Barnsley, the very centre and heart of the South Yorkshire coalfield, enquiry is going on. The Corporation have given notice of their intention to apply for power to supply electricity, and the National Electric Supply Company, amongst whose principal shareholders are several wealthy local gentlemen, is also about to apply for power to supply light and power within the borough. Already several effective installations are working in the town and neighbourhood, and others are continually being introduced. Wentworth Castle, Stainborough, the residence of Mr. T. F. C. V. Wentworth, one of the wealthiest commoners of England, is brilliantly illuminated, some 500 incandescent lamps being used to light up the house. The Co-operative Society's huge flour-mills, warehouses, bakeries, shambles, are all lit by electricity, at a saving of about 60 per cent. as compared with gas. Within the past fortnight a large foundry, and last week the principal boiler works of the town have successfully adopted the same means of lighting, and other firms are considering the question, several being spoken of as likely to adopt it in the early future. The cause of the present ferment on the subject is not far to seek. The directors of the local gas company have raised the price of gas 4d. a 1,000, from 3s. to 3s. 4d. per 1,000ft. The shareholders, timid at first, have been emboldened by the assurances of their chairman, who defies electricity to compete with gas, says it is a failure as a commercial speculation, and that it only succeeds in America because gas is from 6s. to 10s. per 1,000ft., and have approved the advance. They will fight the electric light, they say, and beat it on its own ground. It is very probable that their challenge will be taken. The proposals of the Corporation are looked on with favour. So, too, are those of the National Electric Supply Company, and the latter, perhaps, gives the clearest idea of the reality of the feeling of the district in the matter, for chief amongst its subscribers are Mr. T. F. C. V. Wentworth, of Wentworth Castle; his son, Mr. Bruce C. V. Wentworth, Conservative candidate for the Barnsley Division; Mr. Dan Rylands, a successful and wealthy manufacturer of the district, and Mr. C. H. Cobbold, well known as holding a large stake in several successful local companies. The gas companies try to create a prejudice against the electric light by pointing to losses made in Leeds, Bradford, and elsewhere, and by fearsome pictures of men slowly roasting on the light wires they have been sent to repair, but their efforts do not carry much weight, and it is very probable that Barnsley, with gas-coal collieries surrounding it on every hand, will be one of the earliest Yorkshire towns to effectively introduce the electric light.

THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence ; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices :

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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HORSEFLESH, ELECTRICITY, AND LABOUR.

The peculiarities of Englishmen deserve study, but much study will fail to enable the student to understand them. The Americans have a saying that they invite English capital to initiate the great works in that country, to carry the work on through its initial stages, first of great expectation, then of hope, then of despondency, then of despair, when the American capitalists come in, foreclose, and reap the reward in getting huge dividends, for the time of despair is generally the time when the silver lining is quite close. This farsightedness is attributed to our cousins, yet if the seeker is very keen he will see something which, if not in exactly the same category, must be its twin-brother in this country. Just, too, as it frequently happens that whatever one brother does brings in the gold, and whatever the other does leads to failure, so the English twin-brother may be said to be the failure, for, although he thinks it not, he pays the initiatory costs both at home and abroad. What do these remarks lead up to? Well, the old subject which has so often formed the main topic of our theme, electric traction. The policy of the Englishman, contrasted with that of the American, in this respect is not creditable to the former, while highly so to the latter. The English capitalists look suspiciously upon schemes of electric traction, and say: Let us see that they will pay, prove that they are workable, and we will then consider the matter. The engineer who can carry out the work is not asked, but the charlatan who talks like a cheap jack, and with about as much knowledge and impudence, generally manages to land some fish and considerably picks their bones. Thus the case stands, that the Englishman assists the quack and rejects the assistance of the trained engineer—result, progress is infinitesimally slow. The American, on the other hand, sees when the initial work is done that money can be at once made, and, like the wise man he is, he rushes to the work as fast as he possibly can. He is invading our shores, and he will open our eyes to the possibilities of electric traction if we give him half a chance. The experiments lately made at Birmingham may be said to be due to the Julien interests; those of the Series Traction Syndicate got their impetus from across the Atlantic. The latest phase of the game is that the Thomson-Houston people have seen the nakedness of the land, and have sent over an energetic agent to clothe us. According to some of the more thoughtful minds, the time is ripe for great changes in traction over our tram lines. It remains to be seen if these views are correct and if the opportunities are to be taken. There is a revival in trade, prices are tending upwards, and the inevitable accompaniment is seen in the labour struggles. Tram and 'bus men are dissatisfied with their positions, and threaten to dislocate the busi-

ness relations between master, man, and the public. Under existing conditions if the demands of labour are met, the income, in many cases, will not only not suffice to pay dividends, but be insufficient to find funds to satisfy the demands. Now the agriculturist has said, that he is a benefactor to his kind who shows how to grow two blades of grass where one grew before, and the tram and 'bus companies should enquire if it is not possible to carry more passengers at a less cost, and with a less strain upon bone and sinew by giving up the present system and introducing electric traction. Suppose that the tram companies should really entertain the idea—not in the show-us-that-it-can-be-done fashion, but by saying to a good engineer, Do it—are the engineers prepared to go at the work? Hitherto we know they have really been disgusted at the little support given them. They have been asked to waste brains and money upon chimerical schemes. Will any one, or any half-dozen, be prepared to fit up established lines with electrical plant by altering the existing cars to self-contained electrical cars? At the present time the space occupied is that of the car and horses, the weight moved is that of car and horses. With accumulators, the space occupied would be less, and the weight moved would not be much greater. When new lines are to be considered, no doubt engineers would prefer direct driving, but we are inclined to think that the cost in either case would not be higher than by horse traction, even if it were not considerably less. We believe that the Thomson-Houston Company is fully prepared to guarantee that the cost by electric traction shall not be greater than by horse traction, and as this company has many important lines equipped in the States, and has had as much practical experience as any, the statements made should be trustworthy. What a grand stride in humanitarianism it would be, to get horse or mule flesh replaced by the steam-engine, dynamo, and motor; and it can hardly be controverted that somehow or other we come to look upon the men who mind machinery as belonging to a higher grade than those connected with the stable. The introduction of machinery has a tendency to give new aspirations to men, and though sometimes the transition stage is a troublesome one, yet when that is past labour is certainly in a better position. The problem, then, is an economical one. Tramcars are now run by horses, the men connected therewith are not satisfied with either wages or hours of labour. Will the introduction of electric traction assist to alter this dissatisfaction? We think it will. Those who have tried it in America say it will, and, as we say, some enterprising American firms are prepared to take the risk. If electric traction is cheaper, the money gained will be utilised in two ways—first, a part will naturally go to benefit the shareholders; secondly, a

part may be used to benefit labour. The labour employed upon the tramways will probably be much less, and what there is of it much better paid; an increase of labour would take place in the electrical and engineering industries, so that the labour would be differently distributed and better remunerated. It needs but one company to make up its mind and take the first step, which is always the most difficult. After that other companies must follow suit. We do not imagine that progress will stop here, but, as we have previously said, there seems to be no reason why horses should not be almost entirely superseded by electricity in towns. The public mind will have to think of it, and will come to look upon the innovation first as an eccentricity, then as a luxury, and finally as a necessity. The Sultan has his dogcart, but the idea has not found favour here. Certainly at the last Royal Show an electrically-driven dogcart was shown and admired, but it seems the fate of Mr. Immisch to be somewhat before the times. He has been the pioneer in electric launch work, in electrically-driven dogcarts—that is, in the field of luxury. He has also stood in the front ranks in the industrial world in electrically transmitting power for mining work—witness the two years' success at Normanton, the apparatus of which was on view last Wednesday. Mr. Immisch, however, will agree with us that in this direction of traction or transmission of power electrically, most Englishmen have been only too much inclined to follow the plan of Micawber and wait for something to turn up. Electric traction for tram lines must, however, take its place in England as it has in America, and the recognition of this by the tram engine and car makers, instanced by the transfer of the Falcon Car Works to the Brush Company, may be taken as the beginning of the new state of things to which electric motor makers will have to vigorously apply themselves.

CORRESPONDENCE.

OVERHEAD WIRES.—BOARD OF TRADE REGULATIONS.

TO THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—I am surprised at the very few comments called forth by the introduction of these new regulations which, if enforced, will seriously hinder the progress of electric lighting, besides endangering the public safety. It is only necessary to call attention to a few of the rules to show that they entirely defeat their own object. I refer especially to the compulsory use of steel bearer wires for suspending the copper line wire. What is the actual result of adopting the above rule? In the first place, the tensile strength of the steel wire is only about 25 per cent. greater than that of some of the bronzes at present in the market. The steel naturally deteriorates through rust, and must either be erected with a large amount of sag in the spans, in which case there is danger of the wires blowing together, or if a heavier steel wire (in relation to the size of the copper wire) is used, the strain on the insulators and poles is greatly increased, consequently the chance of a breakdown. Another source of danger is the leather thongs used

to suspend the line wire. These all form points of lodgement for snow, and increase the area on which the wind can act. The use of double wires—steel and copper—of course necessitates the use of double the ordinary number of insulators or shackles, thus greatly increasing the cost of erection and lowering the insulation resistance of the circuit.

Soft copper wire suspended on insulators without any bearer wire is almost equally unsuitable, although far safer than the above arrangement, owing to the stretching of the copper and consequent slackness of the spans. The right sort of line wire for both safety and economy will be found to be bronze wire with a fairly high conductivity—say 80, per cent.—a high tensile strength, and, what is more important, great elasticity. In actual work spans erected of this material will be far safer than any system of bearer wires.

The use of stranded wires for overhead lines should be compulsory, and also the use of draw-vices with a spring gauge attached to measure the strain of the wire during erection. If these were used there would be no need of the absurd rule "that no span must be longer than 200ft." It seems to be a common idea in some quarters that a long span is more dangerous than a short one; it is needless to say that this is not the case if the wire in both cases is pulled up to the same tension, and the only practical way of doing this is the use of some sort of spring gauge, as there are few ordinary linesmen who are able or willing in every case to measure the exact sag in centimetres by sight, as some of our electrical "experts" would no doubt recommend.

A proper system of Government inspection should also be adopted. The inspectors, however, should be intelligent men, and it might be as well that they should have an elementary knowledge of practical work, besides their theoretical knowledge.

To my mind the electric lighting industry has already suffered sufficiently through the attempts which are constantly being made to introduce apparatus or systems of working which are not yet a practical success, as, for example, "storage" cells, or underground high-tension wiring. In the case of provincial towns or scattered districts the use of a costly system of pipes or conduits with cables of 50,000 megohms, as used by some of the London supply companies, is necessarily prohibitive, and it is evident that if overhead wiring is restricted by regulations (which merely increase the cost of erection, and endanger the public safety), the progress of electric light and power supply must be seriously hindered.—Yours, etc.,

Crouch End, N.

W. M. HITCHCOCK.

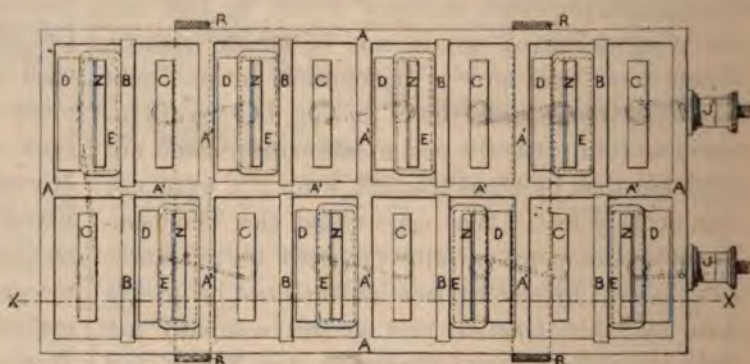
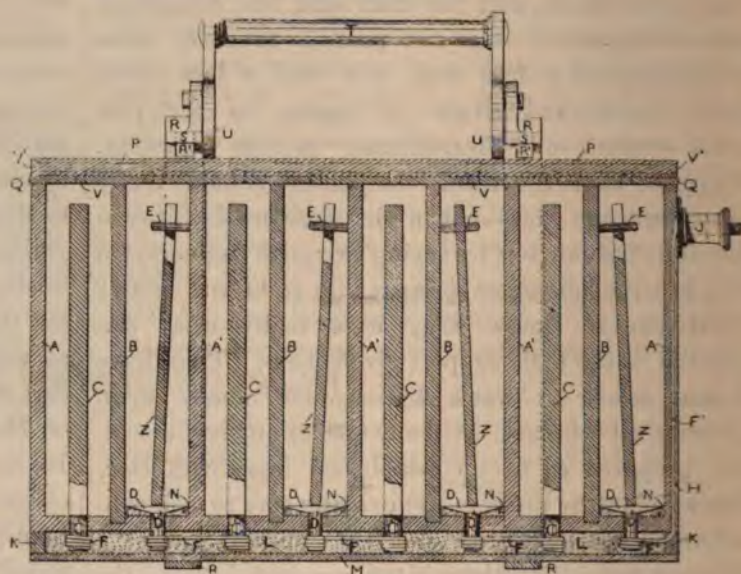
HARRIS' PRIMARY BATTERY.

In a recent issue we called attention to this battery. The patentee has certainly overcome certain mechanical defects, as will be seen from the accompanying illustrations. The idea of getting rid of almost all binding screws or other contact pieces, whereby loose contacts, corrosion, etc., are avoided, and replacing them by contacts taking the current from the bottom of the cell, is an ingenious one, and applicable to all batteries. Of course, the user is not able to arrange the cells in any way he pleases, but for many purposes this does not matter. The fixing of the carbons, again, is not new, nor the amalgamation of the zincs. We have had this battery under notice for several weeks, and have seen no signs of bad contact, hence no loss of current because of such defect. We give herewith the patent claims, which are for purely mechanical construction, and for nothing else. They are:

1. A voltaic battery, having the connections between the elements arranged under the bottom of the battery and

completely enclosed and insulated from one another and from the contents of the cells.

2. In a voltaic battery, the use of carbon elements, C, having studs, C¹, passing through and cemented into the bottom of the battery, and zinc elements, Z, resting upon studs, D, also passing through and cemented into the bottom of the battery, the connections being formed by wires, F, all enclosed in cement, L, and encased by the frame, K, and plate, M, as shown in the figures.



3. In a voltaic battery the use of carbon elements, C, having studs, C¹, passing through and cemented into the bottom of the battery, and zinc elements, Z¹, resting upon studs, D, passing through and cemented into the bottom of the porous cell and the battery, the connections being formed by wires, F, all enclosed in cement, L, and encased by a frame, K, and plate, M, as shown in the figures.

THE LIGHTING OF THE CENTENNIAL INTERNATIONAL EXHIBITION, MELBOURNE, 1888 AND 1889.*

BY K. L. MURRAY, C.E., TELEGRAPH ENGINEER TO THE VICTORIAN RAILWAYS, MEMBER.

(Continued from page 395.)

A pulley was accordingly constructed, the principle of which is as follows: The energy supplied to the machine is transmitted through a fixed point at a distance intermediate between the axis of the spindle and rim of the pulley. By means of levers and pistons the pressure is transmitted to a fluid filling the chamber in which the piston moves, and by it through a glass tube which lies in the axis of rotation to a spring chamber the capacity of which varies with the pressure on the enclosed fluid. The pressure on the point through which the energy is trans-

* Paper read before the Institution of Electrical Engineers on Thursday, November 14,

mitted is shown by the displacement of the fluid in the glass tube. The pulley was made so that the rim, R, could turn freely on the nave, N. Two radial chambers, C, were carefully bored in the nave at the opposite ends of a diameter, and pistons were accurately fitted in them, so that though watertight they could move freely. Two bent levers, L, were hinged at the nave, each being so shaped that when one arm pressed on the centre of the piston, the line passing through this point of contact and the centre of the hinge, was at right angles to the radius drawn through the point of contact. At the same time the other arms of the levers stood in a direction such that the surface of the lever remote from the piston coincided with the radius passing through the centre of the hinge. These arms were of such length that they just cleared the inner surface of the pulley rim. The connection between the rim and nave was made by means of two blocks of iron, B, riveted to the inner surface of the rim in such a position that they would come in contact with the projecting arms of the levers. The point of pressure was rendered definite by the use of knife edges, and any shock was relieved by the interposition of a suitable spring. Two small holes were drilled parallel to the eye of the pulley opening into the cylinders. The indicating apparatus was fixed so that it would coincide with the axis of rotation when the pulley was in use. It consisted of a glass tube, with a carefully fitted ebonite piston which served as a marker. This piston was made about 10 diameters long, and had several small grooves turned in it. The glass tube was mounted with a metallic chamber at each end, one being bolted to the pulley nave, the other closed with a circular corrugated steel spring similar to those used in some steam pressure gauges. The metallic chambers were mechanically connected by an iron tube in which three longitudinal slots were cut to enable the glass tube to be seen. The angular width of each slot was 60deg. The scale was fastened on the inner side of the bars of the iron tube; consequently each time a slot turned towards the eye the glass tube and ebonite piston were seen projected on the scale that was fastened to the opposite bar. When in rapid motion the scale appeared as if drawn round the glass tube, and the end of the black ebonite piston formed a well-defined line from which to read. Every tenth division was marked in red, and the fifties were shown by a bright line on the outer surface of the iron tube.

In the pulley used, the diameter of the bore in the glass tube was about $\frac{1}{25}$ th of that of either piston. Hence, if both pistons were in use, the motion of the ebonite piston would be about 1,250 times as great as that of either of the main pistons. The length of the scale was about 6.5in., so that a motion of the main pistons of $\frac{1}{2500}$ th of an inch would cause the indicator to travel over the whole length of the scale. The pulley was arranged so that one or both pistons could be used. By this means the range of the instrument was doubled. Using one piston and running at 900 revolutions per minute, the maximum reading corresponded to about 30 h.p., and with both pistons to about double that value.

It will be seen that a dynamometer of this form may be constructed to fulfil fairly well the conditions laid down as essential.

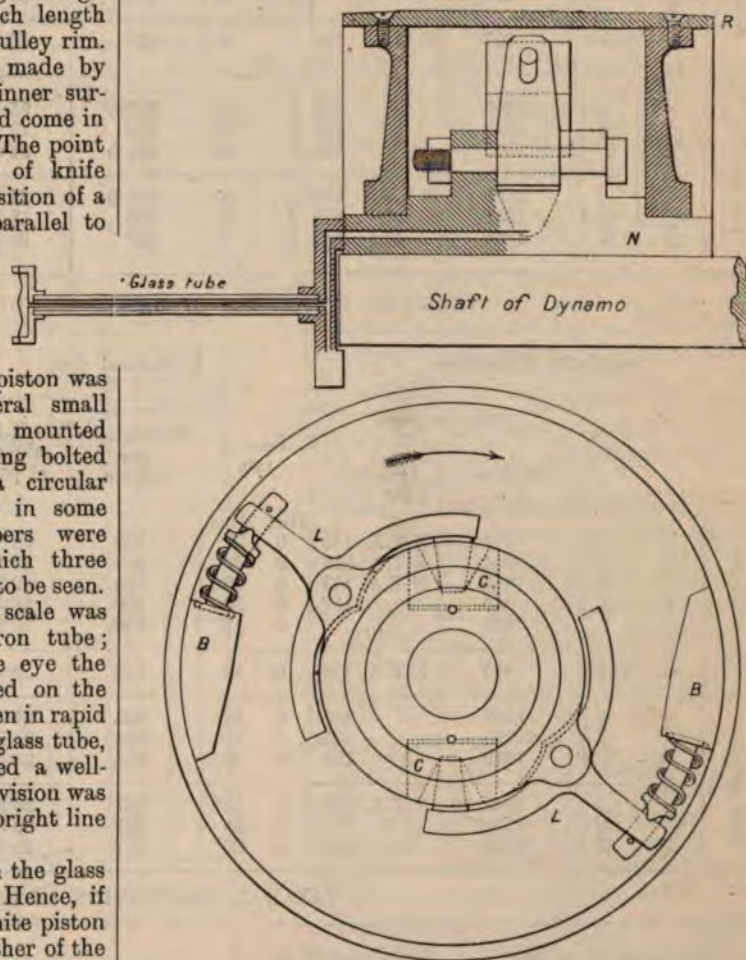
The sensitiveness is determined by the stiffness of the steel spring and length of glass tube used. In practice a very great degree of sensitiveness is not required, as the variations in the power absorbed were found to exceed two, or at times even three per cent. of the total, whereas one-half per cent. could have been easily read. The ammeter showed fluctuations in the current at least equal in relative magnitude to those shown by this mechanical dynamometer.

To calibrate the dynamometer pulley it was keyed on a fixed horizontal spindle. A long balanced arm was bolted to the rim, and at a distance from the centre of the spindle (measured horizontally) equal to $\frac{20}{2\pi}$ feet a screw was put into the lever. Various weights were suspended from the screw, and the corresponding displacement of the ebonite piston noted. It was found that the displacement was

directly proportional to the load; hence the scale could be so divided that the readings would show at a glance the tangential pull of the belt in pounds at any given radius. In the pulley used the constant was calculated for a radius of $\frac{10}{2\pi}$ feet. The reading showed at once the tangential pull

at this radius, and, multiplying by 10, the number of foot pounds absorbed per revolution of the armature.

It should be noted here that the levers in the pulley were counterbalanced for the centrifugal force of the pistons and fluid below them. The correctness of the balancing was tested by mounting the pulley on a spindle and rotating it rapidly in both directions, first of all having removed the



rim. If the balancing were correct a small deflection should be produced, its direction depending on the direction of rotation, and the two deflections should be equal at the same speed of rotation. No error was detected owing to the unequal distribution of the fluid pressure on the circular spring caused by centrifugal force. This fact is not surprising when it is remembered that the effective diameter of the spring was only 1.25in., and the fluid (glycerine) used was light.

The dynamometer pulley was placed on the machine which it was desired to test, in the daytime, and fresh glycerine put in. One of the bolts holding the field-magnet core was taken out, and a similar one, but with a hole bored in it to receive the thermometer, put in its place.

The electro-dynamometers were always carefully adjusted for position after all machines were in full work, so that no disturbing effect would be introduced by the action of the current in leads which ran near the testing table. Each reading noted gave the mean position of the indicator for about 15 or 20 seconds in all measurements, whether electrical or mechanical.

The speed of the armatures was determined by one of Harding's counters, in all cases a full minute being taken.

The constants of all electrical instruments were calculated for the mean temperature of the dynamo-room—27deg. centigrade. The temperature correction for the dynamometer pulley was not determined, as only the first or last

TABLE A.—EFFICIENCY OF BRUSH ARC DYNAMOS (No. 7L), HOT.

Description of machine.					Mechanical data.					Electrical data.			Commercial efficiency.	
			Maker's number.			Time of run.	Revolutions per minute.	H.P. absorbed at pulley.	Current in amperes.	At terminals.		—	Mean.	
			Machine.	Armature.	P.D. in volts.					E.H.P.				
Solid frame.	Armature plates.	Thin.	457	N.T.A.	149	Hrs. Mins.	930	17.64	9.396	1,149.5	14.47	%	%	
			924	N.T.A.	146	3 11	930	20.16	9.899	1,247.7	16.55	82	} 78.7	
			454	N.T.A.	143	3 48	935	21.43	9.707	1,234.9	16.07	81.9		
			460		157	3 24	930	22.89	10.1	1,220	16.52	74.9		
			462	...		3 0	930	19.95	9.731	1,261	16.46	72.17		
					3 0	930					82.56			
		Thick.	467	N.T.A.	184	3 35	930	23.34	9.861	1,232	16.28	69.75	69.75	
Rail pattern.	Armature plates.	Thin.	1846		158	2 33	928.6	23.18	9.988	1,292.7	17.31	74.7	} 77.43	
			1840		152	3 20	932	18.99	9.783	1,197.4	15.74	82.8		
			1849		161	3 20	930.6	24.66	10.001	1,376.9	18.45	74.81		
		Thick.	1843	N.T.A.	188	3 30	924.5	23.08	10.089	1,251.6	16.92	73.31	} 69.84	
			1861		172	3 27	935	18.99	9.265	1,033	12.83	67.56		
			1856		167	3 0	917	26.8	10.129	1,350.6	18.34	68.65		

TABLE B.—EFFICIENCY OF BRUSH ARC DYNAMOS (No. 7L), COLD.

Description of machine.					Mechanical data.				Electrical data.			Commercial efficiency.	
—			Maker's name.		Time of run.	Revolutions per minute.	H.P. absorbed at pulley.	Current in amperes.	At terminals.		—	Mean.	
			Machine.	Armature.					P.D. in volts.	E.H.P.			
Solid frame.	Armature plates.	Thin.	457	N.T.A. 149	Hrs. Mins.						%	%	
			924	N.T.A. 146	0 37	930	18.59	9.745	1,132.6	14.79	79.6	74.29	
			454	N.T.A. 143	0 30	913	22.24	10.495	1,231.9	17.32	77.8		
			460	157	0 10	920	22.74	10.127	1,204.2	16.34	71.85		
			462		0 30	930	22.47	9.3	1,295.3	16.14	71.82		
			...	0 12	930	24.57	10.313	1,251	17.29	70.37			
		Thick.	467	N.T.A. 184	0 15	930	25.8	10.423	1,232	17.22	66.74	66.74	
Rail pattern.	Armature plates.	Thin.	1846	158	0 10	908	24.32	10.423	1,263.6	17.6	72.8	71.43	
			1840	152	0 27	914	22.26	10.202	1,168.4	15.97	71.7		
			1849	161	0 25	934	25.59	10.239	1,303.2	17.88	69.8		
		Thick.	1843	N.T.A. 188	0 35	927	23.82	10.239	1,231.9	16.91	70.99	68.27	
			1861	172	0 35	920	20.51	9.428	1,036.7	13.10	63.87		
			1856	167	0 28	917	26.96	10.495	1,341	18.86	69.95		

TABLE C.—ALTERATION IN EFFICIENCY.

Description of machine.				Temp. cent. F.M. core.		Current.		Commercial efficiency.		Differences.			
—			Maker's number.	Cold.	Hot.	Cold.	Hot.	Cold.	Hot.	Tempera- ture.	Current.	Efficiency.	Mean.
Solid frame.	Armature plates.	Thin.	457	deg. 30.5	deg. 60	9.745	9.396	79.6	82	deg. +29.5	— .347	% + 2.4	} 4.42
			924	...	...	10.494	9.899	77.8	81.9	...	— .595	+ 4.1	
			454	29.4	71.1	10.127	9.705	71.85	74.9	+41.7	— .422	+ 3.05	
			460	38.8	56.6	9.3	10.1	71.82	72.17	+17.8	+ .8	+ .35	
			462	32.2	66.6	10.313	9.731	70.37	82.56	+34.4	— .582	+12.19	
		Thick.	467	33.3	68.2	10.423	9.861	66.74	69.75	+34.9	— .562	+ 9.01	9.01
	Rail pattern.	Armature plates.	Thin.	1846	...	...	10.423	9.988	72.8	74.7	...	— .435	+ 1.9	} 6.0
1840				...	...	10.202	9.783	71.7	82.8	...	— .419	+11.1	
1849				28.3	65.16	10.239	10.001	69.8	74.81	+36.86	— .238	+ 5.01	
Thick.			1843	28.8	47.1	10.239	10.089	70.99	73.31	+18.3	— .15	+ 2.32	} 2.44
			1861	...	...	9.428	9.265	63.87	67.56	...	— .168	+ 3.69	
			1856	40.5	68.8	10.495	10.129	69.95	68.65	+28.3	— .366	— 1.3	

two or three readings were to be used in the results, and the accuracy of these was ensured by taking the zero of the pulley both before and after the machine was run. The intermediate readings were taken only to show if any serious alterations took place in the general working of the machines.

These tests, the results of which are tabulated (see table A), were made primarily to ascertain the commercial efficiency of the various arc machines used. By "com-

mercial efficiency" I mean the ratio of the electrical energy available at the terminals to the actual energy absorbed at the spindle of the machine.

It will be seen that the current actually supplied by the majority of the machines was a little below the normal, the machines being professedly designed for a current of 10 amperes.

The times of run, as shown in the table, were not sufficient for the machines to attain their state of steady tempera-

ture, though in the majority of cases the temperature reached would be a fair average for ordinary working.

The armatures of the machines were interchangeable, so that any given armature cannot be considered a part of any specified machine; it was important, therefore, to ascertain not only the relative value of the different forms of frame, but also of the different armatures in them.

It will be seen from the table that the different forms of machine having thin-plate armatures are almost equally efficient, the solid-frame pattern having a slight advantage. The difference, however, between the two forms of machine with thick-plate armatures is still less, and the advantage in favour of the rail pattern. But as only one of the solid-frame machines contained a thick-plate armature, the comparison is of little value. For practical purposes, it may be said that the commercial efficiency of the two forms of machine, provided the armatures are similar, is the same. Greater alterations in the efficiency of either class may be caused by slight alterations in the conditions of working than the actual difference between the two classes, as shown in the table.

The difference in the two types of armatures is very marked. Taking the mean from the two classes of machines, the efficiency of the thin-plate armatures will be found to be about 8.27 per cent. greater than that of the thick-plate armatures. But, unfortunately, the thin-plate

The resistance of the voltmeter used was great, so that the potential difference as shown by it was practically the E.M.F. of the machine.

As the number of windings and speed of rotation of the armatures were the same, the E.M.F.'s would be directly proportional to the total induction through the armatures.

The induction through the armatures depends on the magnetising force, H , of the current in the field-coils, and the goodness of the magnetic circuit.

In the machines tested, the number of windings on the field-coils were equal. Hence, the E.M.F.'s of the different machines, when taken with the same current in the field, will represent the relative values of their magnetic circuits.

The curves may be taken either as saturation curves of the total magnetic circuit, or as curves of total induction through the armature, provided no sensible current is taken from it.

An examination of the curves in diagram I. will show a small magnetic advantage in favour of the solid frames. This result was expected from the fact that the bedplate increases the effective cross area of the field-magnet yokes, but is not likely to materially increase the magnetic leakage owing to the great length of circuit.

The early part of curve of dynamo No. 460 was taken with the very greatest care. Only a few of the points are marked for clearness, as the curve passed evenly through them all.

The usual concavity at the commencement is shown in a marked degree. The slow rise of this curve for low degrees of excitation seems to indicate a greater degree of hardness of the iron. All the curves approximate to the same form over that portion of their length which corresponds with the ordinary range of excitation.

Table B shows the conditions of running and general behaviour of the machines shortly after starting. Very little more time was allowed before the measurements were taken than was necessary for the lamps to assume a proper working condition. At times, however, the tests had to be postponed till the machinery attained its normal speed. It will be seen that the current in most cases was above 10 amperes.

In table C the more important values given in tables A and B are compared, and their differences, with their proper signs, are added, to enable the alterations which take place, when the machines and lamps are heated, to be more readily detected.

The current in every case but one fell as the evening advanced. This reduction is mainly due to the increase in resistance (due to heat) of the shunt circuit in the lamps. The effect of this is to lessen the action of the fine wire in the differential coils and allow the carbons to be separated a little farther; that is, to increase the potential difference required at the terminals of the lamps.

In 10 out of 12 of the arc machines tested, the commercial efficiency was found to increase with the reduction of current that took place from the above cause. In the other two machines the current and efficiency rose or fell together. A comparatively small increase of current above the normal is found to produce a sensible diminution in the efficiency. Hence, in practical work it is important to ascertain the most efficient current to take from the machines, and see that it is always maintained at that value. The increase in the efficiency may be partially due to a reduction in the losses caused by Foucault currents in the armature and field-magnets, brought about by an increase in the specific resistance of the metal by heat. The loss due to magnetic viscosity in the armature core may also be lessened by the same agency.

It will be seen that the average output of the machines is much about the same whether they are hot or cold.

Total output of 12 machines, cold	199.42 e.h.p.
" " hot	195.94 "
Difference ...	3.48 "

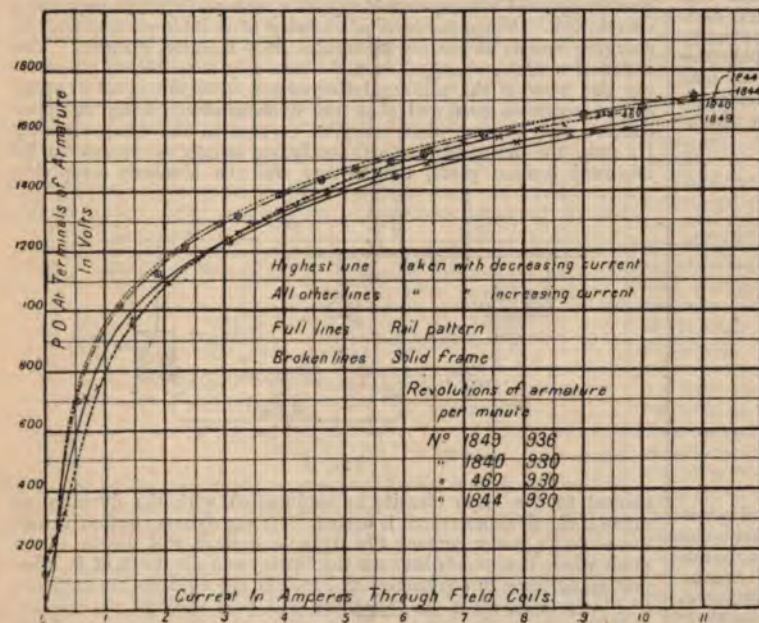


FIG. 1.

armatures were not calculated to withstand the mechanical strains to which they are subjected in ordinary work, so the higher efficiency obtained from them has only a theoretical existence. There is, however, no mechanical reason why the armatures should not be constructed with thin plates, and at the same time be free from the mechanical faults shown to exist in those under review. Indeed, such armatures have been constructed in the Victorian Railways Telegraph workshops which are quite free from the faults named. One of these has been running for several years without ever giving trouble, and doing excellent work.

The curves in the diagram (Fig. 1) were taken to ascertain the relative value of the magnetic circuits in the two classes of frames. The method adopted was as follows:

The commutator brush-holders were electrically disconnected from the field-magnet circuit. The ordinary brushes were taken out and replaced by others so bent that contact could be made with the commutator at the neutral point. The armature was run at the normal speed, and the field-magnets were separately excited by a variable current taken from an incandescent circuit.

Simultaneous readings were taken of the current through the field-coils, the potential difference at the terminals of the armature, and the speed of rotation. From these data curves were plotted as shown in the diagram.

All the machines tested in this manner had similar thin-plate armatures.

Total power absorbed at pulleys by 12 machines,
cold 279.77 h.p.
" " " hot 261.11 "

Difference..... 18.66 "

The power absorbed by the machines is much less when they are hot; the total reduction in the 12 tested being 18.66, or 1.5 h.p. per machine, while the diminution in the output was little more than a quarter horse-power per machine. This fact accounts in some measure for the gradual increase in the speed of the engines (which has been previously mentioned) as the evening advanced, though the steam pressure and number of machines driven remained constant.

(To be continued.)

SOME METHODS OF REGULATING ACCUMULATORS IN ELECTRIC LIGHTING.*

BY GEO. B. PRESCOTT, JUN.

(Concluded from page 399.)

In applying accumulators to plants operated on the three-wire system, a simple extension of the method already described is adopted, except in the case of small stations requiring only one series of accumulators, and where the working circuits can be multiplied during the light load, so that the ordinary method will suffice. In larger plants the batteries are installed in pairs, each series having the same apparatus as before; and as this has already been fully explained, it will only be necessary to add that in adapting two series of cells to the three-wire system, the two batteries are connected in series in the same manner that the dynamos are connected. The general plan of this arrangement is shown in Fig. 7, from which

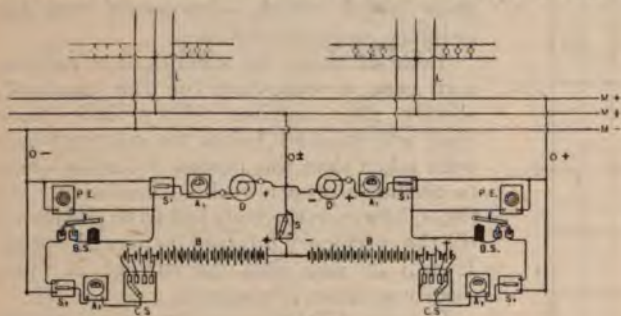


FIG. 7.

unimportant details have been omitted. At the top of this diagram the three horizontal lines, M (+), M (±), and M (-), represent the omnibus wires in the dynamo-room, from which the feeders, L, are led. The three vertical lines, O (+), O (±), and O (-), are extensions to the omnibus wires to which the dynamos are directly connected in the usual manner when the levers of the switches S₁ are on their upper contacts. The batteries are also connected with the omnibus wires in a similar way, so that when the switches S₂ are closed on their lower contacts the batteries will also discharge into the lamp circuits in parallel with the dynamos. Now if the switches S₁ are turned to their lower contacts, and the switches S₂ to their upper contacts, the current from the dynamos will divide at the switches S₁, part going into the lamp circuits, and part through the batteries, which thus receive a charge. As in the multiple arc system, the potential of the dynamos being assumed to be raised above the normal to meet the requirements of the batteries, in order to suitably reduce the pressure on the lamp circuits, it is only necessary to adjust the resistance of the pressure equaliser, P.E. In central stations, where the feeders are already provided with pressure equalisers, the connections are still more simple, for the batteries are merely connected to the omnibus wires, while all other connections of the ordinary three-wire station are unchanged. In such cases, the increased pressure at which the dynamos are operated during the time the batteries are charging is reduced at the lamps to the proper point by the usual adjustment of the feeder or pressure equalisers. During the charging period all the regulation of the accumulators may be dispensed with by opening the switch S₁, when both batteries will be connected in a single series to the full pressure of both dynamos. In addition to the apparatus shown in the diagram, each series of cells is provided with a double plug switch and sockets suitably disposed, by means of which the relative positions of the batteries on the two sides of the system may be changed by simply transposing the plugs from one socket to the other. The object of this arrangement is to provide means for compensating for the unequal discharge of the batteries when the two sides of the lamp system are unbalanced; and the transposition is never made oftener than once each day. In all other respects the manipulation of accumulators when applied to three-wire systems is practically the same as when they are operated on the multiple arc plan. To increase the accumulator capacity of three-wire stations,

* Paper read before the American Institute of Electrical Engineers, New York, October 29, 1889. From an advance proof from the *Electrical World*, New York.

double batteries are added in parallel to the first set, just as additional dynamos would be.

It was explained further back that the extra, or regulating, cells in each series often become charged sooner than the remainder of the cells, and required to be removed from the circuit before the others. This operation, of course, calls for some labour, and, little as it is, it would still be desirable to have the number of cells in a series remain fixed both during charge and discharge. By the use of what are called counter E.M.F. cells, this result may be effected, and at the same time the pressure equaliser be dispensed with. These very simple cells are made like an ordinary Planté accumulator, of plain sheets of an inoxidisable lead alloy, and without active material. When a current is passed through them they act as gas voltmeters, and while they instantly oppose a counter E.M.F. of about two volts, they are incapable of producing a current of any appreciable amount of duration on account of their inoxidisable property. The use of counter E.M.F. cells in place of equalisers is advantageous in several ways, for not only may their internal resistance be made so small as to be practically negligible, but their counter E.M.F. is as effectual in reducing excessive pressure as a dead wire resistance, while possessing the unequalled advantage that the fall in potential of the current passing through them is unaffected by any variation in the strength of such current.

The method of using these counter E.M.F. cells is shown in Fig. 8, which represents a single series of accumulators installed in connection with a direct lighting plant operating one dynamo, as first described, and for simplicity and effectiveness this method cannot be well exceeded. The dynamo is connected to the lamp mains, as before, through an ammeter on one side, and through the upper contact of a two-way switch, S, on the other; while the battery, B, is similarly connected to the lamp mains on one side, but on the other the circuit is completed through several counter E.M.F. cells, K₁, the number opposed being governed by the position of the cell-regulating switch, C S. When the lever of switch S is on its lower contact, the charging circuit is completed in the now familiar manner. The action of a plant arranged in the above way is as follows: Assuming the lever of the cell-regulating switch to be turned off or open, as the expression goes, and that the dynamo switch is on its upper contact, the dynamo alone supplies current to the lamp circuits. If, now, the lever of the cell-regulating switch is turned to its left-hand contact plate, the battery will be similarly supplying

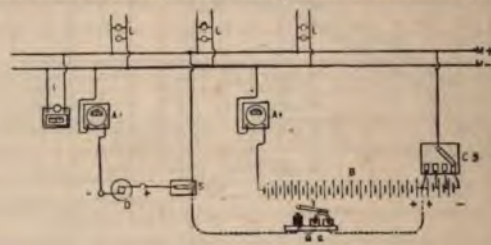


FIG. 8.

current to the lamp circuits in conjunction with the dynamo, or alone if the dynamo switch is opened. If the dynamo switch is now turned to its lower contact the dynamo current will divide at the point where it connects between the battery and counter E.M.F. cells, part going through the battery and back to the dynamo through the (-) lamp main, while the remainder will pass through the counter E.M.F. cells to the lamps. Thus, while the full pressure of the dynamo current will be effective at the battery terminals, its pressure at the lamps will be less by two, four, six, etc., volts, according as one, two, three, etc., counter E.M.F. cells are opposed to the passage of the current into the lamps by the position of the lever of the cell-regulating switch.

When the battery has been fully charged and it is desired to stop the dynamo, the latter may be disconnected by opening the switch S₁, when the battery alone will maintain the lamps. As previously explained, the potential of the battery will be a maximum immediately after it has received a charge, so that in this case, if the battery has the usual allowance of extra cells, its potential will be higher than the lamps require. More or less of the counter E.M.F. cells may now be inserted in the lamp circuit, however, until the potential is suitably adjusted. Although during the greater part of the discharge the E.M.F. of the battery will remain fairly constant, if discharged to its limit the potential will slowly fall toward the end, and this fall must be compensated for by removing one or more of the counter E.M.F. cells from the lamp circuit.

It is to be noted that, by means of the above method, the number of cells in the battery proper is fixed and unalterable during both the charge and discharge, and that whenever the dynamo is supplying current to the lamps its surplus current is always available for charging the battery; moreover, only one adjustment of the counter E.M.F. regulating cells opposed to the lamp current will be required. It is obvious that counter E.M.F. cells may be substituted with equal effectiveness for the equalisers and regulating cells employed in all of the previously-described systems, and it seems unnecessary to go into any further particulars in order to illustrate the practicability of such systems when properly installed and operated.

We have now to consider another branch of the electric lighting business, in which accumulators also claim a share of attention—viz., the supplying of current to lamps located at a considerable distance from the source of power.

The first method to be considered is known as the half-direct plan, in which one or more series of cells are installed in any number of sub-stations conveniently located near centres of lamp consumption. The charging station may be situated wherever economy dictates,

without any special reference to the location of the batteries, for although the expense of the charging wire and the cost of the energy wasted in it cannot be neglected, both these factors must be offset by the saving effected from locating the power station in the most desirable situation. This half-direct system is so called because during the period of maximum load half the current is supplied by the charging dynamo, and half by the batteries. At other times the dynamo may be simultaneously charging the batteries and supplying lamps, or the battery alone may be in operation. Each sub-battery station is, in fact, a small central station by itself, and it may contain one or several series of cells, the number, of course, depending upon the amount of lighting to be done in its vicinity. A common charging main, like an arc light circuit, passes through each sub-station, and each battery may be inserted in the main or withdrawn from it at will, exactly as arc lamps are cut in and out of circuit. The charging dynamo is usually of high voltage and of moderate current capacity. Machines of 500 volts and 15 amperes to 1,200 volts and 40 amperes may be employed in small stations, while in larger ones the latter machines and their circuits may be multiplied. For charging purposes shunt-wound dynamos are preferable on account of their non-reversibility, but even series and compound-wound machines may be used if suitable precautions are taken. The arrangement of the accumulators and regulating apparatus in each sub-station on the half-direct system is essentially the same as the method adopted in the last described multiple arc system. The connections of two sub-stations installed on this plan are shown in Fig. 9, in which station 1 is shown with its switches in position for both its battery and lamp circuits to receive current from the charging circuit; while station 2 is disconnected from the charging line, which is closed outside of it, and the batteries alone supply the lamp circuits. The switch, which is employed to throw the batteries into and out of the charging circuit, is of the snap action type, and is sometimes called a consumer's switch. It maintains the integrity of the charging circuit when the batteries are removed from it, and is provided with a spark coil which prevents the opening of the charging line and the consequent formation of the injurious arc, which results on the interruption of high-potential circuits. It consists in the main of four terminal contact springs, which bear against an insulated cylinder, in which are embedded two rows of metallic contact strips. In one position the two left hand and the two right hand springs are brought into electrical contact, but if the cylinder is rotated slightly the two middle springs will be brought into electrical contact, while the two outer ones are left free, as shown respectively at

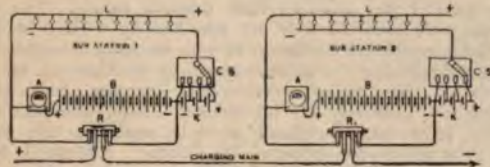


Fig. 9.

R and R₁. As before stated, this change is effected rapidly and without breaking the circuits. These switches are usually operated by hand at the beginning and end of a charge, at which time whatever inspection of the cells is necessary is also generally made. By applying the polarised magnet principle to this switch it can be made to operate automatically from the central station through a momentary reversal of the charging current, a principle which has already been applied.

While the method just described of locating the batteries in sub-stations near the lamps to be supplied reduces the resistance of the supply wires to such an extent that the variation of potential with changes in current strength is unimportant compared with what it would be were all the lamps operated from one central point, under ordinary conditions, still a similar variation does occur from a different cause. We have already seen that the potential of a battery is higher while it is being charged than at other times, and that the greater the charging current the higher the potential of the battery becomes. It is evident that if charging commences when only a very few lamps are burning in a given battery only a small part of the charging current will be required by the lamps, while the greater part will pass through the battery. This will raise the potential of the battery considerably, and as the lamp mains are permanently connected to its terminals the lamps will receive an excessive pressure. As the number of lamps increases, however, more of the charging current will pass to them and less through the battery, the potential of which thus becomes gradually reduced until it reaches a minimum, when the number of lamps burning becomes so great that the whole output from both the dynamo and battery is required to maintain them. The variation is in the opposite direction, of course, when the lights are diminishing in number. It is evident from the preceding facts that during the period when the charging dynamo is running, and the lamp loads are varying, some regulation of the pressure at the lamp mains at each sub-station is required. This regulation is automatically effected by means of the apparatus shown in Fig. 10, in which a solenoid magnet, A R, and a polarised magnet, P M, are inserted in the battery circuit. In all other respects the relative positions of the battery, lamps and charging circuits remain unaltered from the arrangement shown in the last diagram. The operation of the apparatus in this sub-station will be as follows: Assuming the charging dynamo to be delivering a current through the charging main, M, and that the consumer's switch is in the position shown in the diagram, the charging current will pass from M (+) to the point Q, where it will divide, part going through the lamps and the opposed counter E.M.F. cells, K, to the point L, and thence to the line again, the

remaining part of the current passing from point Q, through the magnets, P M and A R, and out through the battery to point L and line. When the current is flowing in the direction of the arrow, as in the case just cited, the armature of the polarised magnet is moved to its left-hand contact, as shown, and the plunger of the solenoid magnet is more or less drawn down, according to the strength of the current. This action of the solenoid magnet causes one or more counter E.M.F. cells to be inserted in the lamp circuit in such a way as to oppose their E.M.F. to that of the charging current, while the full pressure of this current is available at the battery terminals. If now the number of lamps is increased to such an extent that not only all of the charging current passes through them, but also that more or less current from the battery joins in parallel with it, then the current from the battery will traverse the polarised magnet in the opposite direction from that previously taken by the charging current, and its armature will be moved against its right-hand contact, thus short-circuiting the solenoid magnet and the counter E.M.F. cells, as

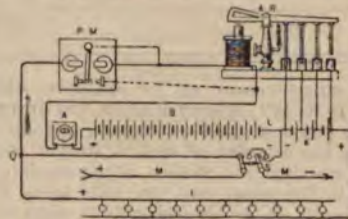


Fig. 10.

indicated by the broken line. For, as the sketch shows, the lever of the solenoid magnet is so balanced that when no current is traversing the magnet its metallic contact-rods all dip into their respective mercury cups, and so shunt around the counter E.M.F. cells with which the latter are in electrical connection. When the lamp load becomes reduced and the charging current is discontinued either by the stoppage of the dynamo, or by its being shunted past that particular battery by a movement of the switches to the right, the battery alone works into the lamp circuit, and the counter E.M.F. cells are short-circuited.

While the automatic regulator just described, when applied to the half-direct system, maintains the pressure at the lamps sufficiently uniform for practical purposes, whether the charging dynamo is operating or not, and although the proximity of the battery to the lamps it supplies prevents undue variation of potential when the load changes, yet a perfectly automatic method of maintaining a constant potential at the lamp circuits, even where the resistance of the leads is great, would be generally useful. Such a method is illustrated in Fig. 11, in which the battery, counter E.M.F. cells, lamps, and charging circuits occupy the same relative positions as before. The solenoid magnet of the regulator is no longer in series with the battery, however, and is, in fact, entirely disconnected from it, while the polarised magnet is replaced by a second solenoid magnet, P M, wound to high resistance. The armature lever of this second solenoid is so mounted that when its core is attracted or released this lever moves over a series of contact strips, which are insulated from each other. Connected with these contact strips are coils of wire of suitable resistance, the whole constituting a simple rheostat, more or less of the wire of which is included in a local circuit, according to the position of the lever, which acts as a movable contact. The solenoid magnet of the regulator, A R, and one or two cells of the accumulators are also included in the local circuit referred to, the strength of the current flowing in this circuit depending upon the amount of resistance inserted by the movement of the lever of the pressure magnet, P M. The latter magnet is connected directly with the battery terminals, and as the potential of the battery rises and falls, the current flowing through this

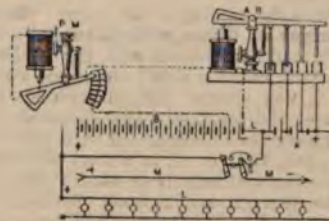


Fig. 11.

magnet varies correspondingly, causing a similar variation in the current in the local circuit. Thus an increase of pressure at the lamps which are connected to the battery terminals indirectly causes the armature of the regulating magnet, A R, to be attracted, and this, in turn, opposes one or more counter E.M.F. cells in the lamp circuit until the pressure again becomes normal. If the pressure at the lamps falls below normal, the regulator acts in the reverse way, cutting out the counter E.M.F. cells until the normal pressure is again restored. If in connection with this method the polarised consumer's switch, previously mentioned, is substituted at S, the operation of such a sub station will be entirely automatic.

It is proper to mention that the pressure magnet must be very sensitive, and requires a delicate adjustment, besides being somewhat costly on account of the excellence of the workmanship required. Although I have only seen the instrument used in an experimental way, its practical application to similar purposes has given satisfactory results.

TABLE A.—List of Electrical Accumulator Company's Standard Cells. (Approximate Data)

Type of cells.	Charging current.	Working rate and capacity. Amperes.				External dimensions of jars. Inches.						Weight of acid.		Weight complete cell.		Height over all, including connections.	
	Normal.	Normal.		Maximum.		Glass.			Rubber.			lb.		lb.			
		Amperes.	Rate.	Ampere hours.	Rate.	Ampere hours.	Length.	Width.	Height.	Length.	Width.	Height.	Glass.	Rubber.	Glass.		Rubber.
15 L	15 to 30	30	300	40	250	10 $\frac{3}{4}$	12 $\frac{1}{4}$	13 $\frac{3}{4}$	—	—	—	50	—	130	—	15 $\frac{1}{2}$	
23 M	10 to 25	25	150	30	110	10 $\frac{3}{4}$	8 $\frac{3}{4}$	9 $\frac{3}{4}$	6 $\frac{3}{4}$	7 $\frac{1}{4}$	9 $\frac{1}{4}$	16	11	50	40	11 $\frac{1}{2}$	
15 M	5 to 15	15	100	20	70	7 $\frac{3}{4}$	8 $\frac{3}{4}$	9 $\frac{3}{4}$	4 $\frac{3}{4}$	7 $\frac{1}{4}$	9 $\frac{1}{4}$	11	7	35	25	11 $\frac{1}{2}$	
7 M	2 to 6	6	40	8	25	4 $\frac{3}{4}$	8 $\frac{3}{4}$	9 $\frac{3}{4}$	2 $\frac{3}{4}$	7 $\frac{1}{4}$	9 $\frac{1}{4}$	6	3 $\frac{1}{2}$	20	13	11 $\frac{1}{2}$	
5 S	1 to 2	2	8	3	6	—	—	—	1 $\frac{3}{4}$	3 $\frac{3}{4}$	6 $\frac{1}{4}$	—	—	—	2 $\frac{3}{4}$	7	

E.M.F. of each cell is about 2 volts.

Under certain circumstances, as, for example, when a lighting station is worked to its full capacity at night, but during the day time has ample surplus power, the all-accumulator system may often be applied to increase the capacity of such a station with satisfactory results. In such cases the sub-stations of accumulators are located at distant points in the usual way, the cells being charged during the day and discharged on the lamp circuits at night while the power plant is doing its regular work. The arrangement of the accumulators and regulating apparatus in the sub-stations of the all-accumulator system is practically the same as when the half-direct system is employed, except that a single transfer switch, which transfers the battery from the lamp circuit to the charging circuit, and *vice versa*, is used instead of the consumer's switch.

It is needless to say that all of the methods which have been described of employing accumulators in long-distance lighting may be adapted to existing lighting plants, and that when so adapted the earning capacity of such stations may be considerably increased without extending the capacity of the power plant. For this purpose there will usually be required a special dynamo at the central station, a charging circuit taking in the territory outside of the regular lighting limits, and one or more sub-stations with accumulators.

There are, of course, numerous other ways of utilising accumulators in central station supply systems, such, for example, as the double battery method now operated in England by the Electrical Power Storage Company, in which the dynamos are kept running for 24 hours daily, duplicate sets of accumulators being alternately inserted in the charging and supply circuits at uniform intervals of time, by an automatic mechanical device. But I have limited this paper to a description of some of the simpler methods of accumulator regulations which may be readily adapted to ordinary lighting plants, and, in concluding, can only hope that I have succeeded, to some extent, at least, in showing that when so applied in an intelligent manner, accumulators do occupy a useful place in the industry of electric lighting.

Through the courtesy of the Electrical Accumulator Company, I am enabled to present to the institute this evening the first proofs of some cuts of a new line of standard accumulators recently brought out by that company. The dimensions and capacities of these cells are described in table A.

PHYSICAL SOCIETY.—Nov. 15.

Prof. REINOLD, F.R.S., President, in the chair.

Prof. J. Milne and Lieut. G. F. Eyre were elected members.

Mr. ENRIGHT resumed the reading of his paper "On the Electrification due to Contact of Gases with Liquids." Repeating his experiments with zinc and hydrochloric acid, the author, by passing the gas into an insulated metallic vessel connected with the electrometer, proved that it was always charged with electricity of the opposite kind to that of the solution. The electrical phenomena of many other reactions have been investigated with the result that the gas, whether H, CO₂, SO₂, SH₂, or Cl, is always electrified positively when escaping from acids, and negatively when leaving a solution of the salt. In some cases distinct reversal is not obtainable, but all these seem explicable by considering the solubility and power of diffusion of the resulting salts. Various other results given in the paper tend to confirm this hypothesis. Seeking for an explanation of the observed phenomena, the author could arrive at no satisfactory one excepting "contact" between gases and liquids, and if this be the true explanation he hoped to prove it directly by passing hydrogen through acid. In this, however, he was unsuccessful, owing, he believes, to the impossibility of bringing the gas into actual contact with the liquid. True contact only seems possible when the gas is in the nascent state. Some difficulty was experienced in obtaining non-electrified gas, for the charge is retained several hours after its production, even if the gas be kept in metallic vessels connected to earth. Such vessels, when recently filled, form condensers in which the electricity pervades an enclosed space, and whose charge is available on allowing the gas to escape. Soap bubbles blown with newly-generated hydrogen were also found to act as condensers, the liquid of which, when broken, exhibited a negative charge. This fact, the author suggested, may explain the so-called "fire-balls" sometimes seen during thunderstorms, for if by any abnormal distribution of heat a quantity of electrified air becomes enclosed by a film of

moisture, its movements and behaviour would closely resemble those of fire-balls. A similar explanation was proposed for the phenomenon mentioned in a recent number of *Nature*, where part of a thundercloud was seen to separate from the mass, descend to earth, and rise again. The latter part of the paper describes methods of measuring the contact potential differences between gases and liquids, the most satisfactory of which is a "water dropper," and by its means the potential difference between hydrogen and hydrochloric acid was found to be about 42 volts. Prof. RUCKER asked if the experiment with zinc and hydrochloric acid could be started in the second stage by having the acid partly saturated with salt. Dr. C. V. BURTON thought it probable that contact could be made between a gas and a liquid by shaking them up together in a bottle. In reply, Mr. ENRIGHT said the experiment could be started at any stage, and reversal effected as often as desired by adding either acid or a solution of salt to the generating vessel.

Mr. HERBERT TOMLINSON, F.R.S., read a paper "On the Effect of Repeated Heating and Cooling on the Electrical Resistance and Temperature Coefficient of Annealed Iron." In a paper recently presented to the Royal Society, the author has brought forward an instance of an iron wire, which, when subjected to magnetic cycles of minute range alternately at 17deg. and 100deg. C., had its molecular friction and magnetic permeability reduced respectively to about one-quarter and one-half their original values. The present experiments were undertaken to see whether by such heatings and coolings the temperature coefficient of iron could be brought down to something approaching the number given by Matthiessen for "most pure metals." The wire experimented on was first annealed by heating to 1,000deg. C. for several hours, and allowing to cool slowly in a furnace placed at right angles to the magnetic meridian; the process was repeated three times. Afterwards the wire was covered with paper and wound doubly into a coil. This coil was enclosed in a water-jacketed air-chamber, and connected with a sensitive Wheatstone bridge. Thermo-electric and Peltier effects were eliminated by always keeping the galvanometer circuit closed. By repeated heating to 100deg. C. and cooling to 17deg. C. for long intervals the specific resistance at 17deg. C. was reduced from 11,162 to 10,688 C.G.S. units, after which the operations produced no further change. At the same time, the temperature coefficient increased in the proportion of 1:1.024. From careful determinations of the resistance at different temperatures the formula $R = R_0 (1 + 0.005131 t + 0.00000815 t^2)$ was deduced, whilst that obtained from Matthiessen's results for pure iron annealed in hydrogen is $R_0 = R_0 (1 + 0.005425 t + 0.0000083 t^2)$. Taking his own determination of specific resistance of impure iron as correct, coupled with Matthiessen's law connecting the resistances and temperature coefficients of metals and their alloys, the author finds that the specific resistance of pure iron deduced from Matthiessen's results is from 4 per cent. to 5 per cent. too high. In conclusion, Mr. Tomlinson expresses a hope that the B. A. Electrical Standards Committee may be induced to determine the absolute resistance and temperature coefficient of the pure metals which are in ordinary use. Prof. Ayrton thought Matthiessen's results were expressed in B. A. units, and hence might appear 1 per cent. or 2 per cent. too great. Mr. Tomlinson, however, believed the number he took were expressed in legal ohms. Dr. WALMSLEY asked for what value of the magnetising force the permeability of the iron mentioned in the beginning of the paper was determined, to which Mr. Tomlinson replied that they were much smaller than the earth's horizontal component.

Dr. Thompson's paper on "Geometrical Optics" was postponed.

COMPANIES' MEETINGS.

SWAN UNITED ELECTRIC LIGHT COMPANY.

The seventh ordinary general meeting of the shareholders of the Swan United Electric Light Company, Limited, was held on November 14 at the City Terminus Hotel, Cannon-street, E.C., Mr. James Staats Forbes presiding.

The Secretary (Major S. Flood Page) read the notice convening the meeting.

The Chairman, in moving the adoption of the report, said that he thought he could best explain the affairs of the Company by going through the details of the accounts. Commencing first with the debit side of the profit and loss account, he said that the stock on October 1, 1888, amounted to £9,678. 16s. 9d. The purchases were

£1,615. 10s. 7d., the office expenses, Directors' fees, rent, salaries, etc., were £3,944. 17s. 9d., and Mr. Swan's salary £249. The other items on the debit side were wages and expenses at factories, £5,290. 15s. 2d., depreciation, £1,863. 9s. 1d., sales, ledger reserve, £100, and the balance, £21,042. 8s. 1d. On the opposite side of the account they would see that the sales, less commissions and allowances, stood at £17,665. 0s. 6d., the transfer fees and interest amounted to £1,344. 11s. 3d., the dividend to December 31, 1888, received from La Compagnie Générale des Lampes Incandescentes stood at £885. 11s., and the dividends from the Edison and Swan United Electric Light Company, Limited, £20,117. 12s. 6d., while the stock on hand on September 30 last was put down at £3,770. 8s. 6d. By comparing the stock with the corresponding heading on the debtor side they would notice that there was a considerable diminution, amounting to £5,900. The explanation of that was that the Company could not carry on its business without having in hand, ready for supply, a great number of lamps of various types, which were required in the business. Those lamps must, of course, be manufactured, perfected, and kept in stock, and according to the volume of business would be the proportion which those lamps bore to those which had been manufactured and sold. They had been reduced very largely in number owing to the necessity of revising the whole stock from time to time, and that process would account for the difference in those figures. Another reason why the figure was diminished was that they had thought it prudent in the valuation of those lamps to bring them forward at 1s. a lamp instead of 1s. 3d., on account of the cutting price in Germany. With regard to the item of purchases, £1,615, he wished to explain that there had been a very large diminution in the volume of business last year. The sales in the previous year came to £40,000, and the expenditure was correspondingly higher. The fact was that in the interval they had eliminated from the Company a considerable portion of its business, by parting with their patents to the Compagnie Générale des Lampes Incandescentes in Paris, of which they were now members. They had received in shares a portion of the value of their patents and business, and they now possessed 40 per cent. of the interest in that undertaking. Although that company had only been in operation a short time, the result had been that a dividend had been declared on December 31, 1888, amounting to £885. 11s., or 6 per cent. That company bought a great many lamps of them last year, but that source of sale had now gone into the hands of other people.

He thought they might congratulate themselves upon the fact that the present was the first occasion upon which the directors of the Edison and Swan Company had felt justified in declaring a dividend. They had done it with perfect confidence in its legality and in its wisdom, and, as they remembered, they declared a dividend of 7 per cent. upon the capital invested, with 3 per cent. in addition, with the nature of a claim for contingent value in that company, because the 7 per cent. was cumulative, and had to be satisfied out of profits before the deferred shares could receive anything. They were aware that for a number of years the Edison and Swan Company, like themselves, had to write down losses incurred in the loss of business in former years, and it was not until those losses were written off that they felt themselves free to pay a dividend. That, of course, meant a dividend of 10 per cent. on the Edison and Swan capital, in which, as they knew, they had £208,478. Referring to the item of wages and expenses at factories on the debit side of the account, he said that if the shareholders would carefully dissect them they would see that they bore a very large proportion of the business actually done, apart from the Compagnie Générale and the Edison and Swan Electric Light businesses, and the accounts, of course, but for the dividend paid by those companies, would not be satisfactory; in fact, there would be nothing to divide. The long and short of the matter was that the Swan Company existed as owners of shares in the Edison and Swan Company and the Compagnie Générale of France, which meant a combination on the Continent of Europe of the same character as that which had been so successful in England under the guise of Edison and Swan. They were only beginning; they had all Europe, except Germany, before them, and they had an admirable factory. He did not venture to prophesy with too much decision, but there was every reasonable ground for believing that they would go on the Continent doing what they had done, creating a large business and realising a considerable profit, and the fact of their being able to divide in the first six months of their business 6 per cent., and being able probably to pay a provisional dividend for the half-year ending June of another 6 per cent., was not a bad indication of what they would do in the future. They had not brought the last dividend into the accounts because it had not been returned when they were made up. The Swan Company's business was limited by the Kalk factory in Germany. They had the factory on lease, which terminated next June, and before that time they would have to decide whether they would go on manufacturing lamps, or see if they could not, in combination with the Edison and Swan Company's interests there, hand it over or become partners in the undertaking. Meanwhile, it was necessary to keep that business going, and inasmuch as the lamp was well thought of in Germany, and there was a very large sale, they hoped that they would either merge into a combination upon advantageous terms, or increase the output of that factory to such an extent as to leave a profit on this working. The depreciation of stock—£1,863—was a large item, but that was a precautionary measure. They had thought it possible that circumstances might require them to abandon the Kalk factory altogether at the end of the lease. He need hardly tell them that when they worked machinery in the premises of somebody else there was likely to be a loss upon the transaction, so they had thought it better to write down from time to time the value of that plant. With regard to the balance in hand (£21,042), that was the profit of the year's transaction. As they were aware, there were reasons for withholding the profits which they had made for the last three years. In 1887 they made a profit of £1,720, in 1888 it increased to

£8,332, and in 1889 to £21,042. They had never thought it prudent to divide it, because there were certain outstanding questions connected with the German business. There was some litigation going on for the infringement of the patents, and they might, in the course of time, be liable to damages, and no human being could say what the damages would be. The German Government had a law under which, in order to meet the possibility of claims of that sort, they called upon the Company who were infringers, or who were sued, to deposit a certain sum of money; and they had under that law deposited about £5,000 in the hands of the German Government in Prussian Consols. They had thought it desirable, with a view to meet those damages, to reserve even now a substantial sum out of revenue; therefore they did not propose to divide on that occasion all the profit accumulated during the three years, but to reserve the division to the sum made in the current year.

Coming next to the balance-sheet, he said that the capital was exactly the same amount at which it stood last year—namely, £375,071—while on the other side the cost of patent rights, etc., represented by shares in Edison and Swan and La Compagnie Générale, and patents held by the Company were £329,911. 17s. 8d. The outlay on factories, plant, etc., was £4,317, less depreciation £1,863, making £2,453. After referring briefly to the other items of the balance-sheet, he turned to the report. Paragraph 2, he said, stated that "after paying all current charges, and making allowance for depreciation of plant, there is a credit balance of £21,042. 8s. 1d., to which must be added the credit balance of £10,052. 8s. 11d. brought forward from the last accounts, making a total of £31,094. 17s. The Directors will recommend the shareholders to declare a dividend of six per cent., which will absorb £22,208. 0s. 9d., to be distributed to the shareholders in accordance with clause 77 of the articles of association." The dividend they recommended made them slightly trench upon the accumulated profits of the preceding two years. The next paragraph in the report alluded to the litigation in Germany, which dragged on. What they were trying to do by hook or by crook was to get absorbed in some large company. Although there was no immediate prospect or possibility of that, yet they had some hope of getting competitors to come in. There was one thing about Germany which, perhaps, was worth considering—labour was very cheap there, materials were not dearer, skill was not inferior, and the export trade of lamps to all the rest of the world might in time be a very important one. He had had a good deal to do with Germany and other continental countries, and he could not help thinking that if the present state of things went on in England in a good many branches of manufactures with which he was quite familiar, there would be very little export trade in the future. The combinations to increase the rate of wages and other things, the uncertainties attending manufacture here now, were so great that it was a serious bar to the export trade. He thought that the people most interested would find that out in time. He knew of an enormous manufactory in Germany which exported to every market in the world, including our own colonies. English manufactures had been driven out of the field because they could not succeed, and because the Germans, by their industry, provision, temperance of living, and satisfaction with small profits, could manufacture and deliver at prices which people could not live on here. It was so with lamps, and so it might turn out that a large export trade might be created for their German factories which could not be done in England. The next paragraph in the report referred to the Compagnie Générale des Lampes Incandescentes, which company had established a new factory in Paris, which was brought into work last July, in which lamps were now being manufactured on a considerable scale. During the first six months of its existence the company worked under considerable disadvantages, having had to purchase the lamps required for their business, so that a small dividend only was earned, but there was every reason to hope that they would develop an increasing and profitable trade. They made 5 per cent. on the capital the first year, and he had no doubt that they would do a large business, and if the prices could be kept up to something reasonable it would be a profitable thing, and their investment would be a very good one. In concluding, Mr. Forbes said that that was a red-letter day in the history of the Company, inasmuch as the Directors were for the first time in a position to recommend a dividend to the proprietors. He believed that they were now standing on safe ground, and he trusted that they would be satisfied with the position and prospects of the Company; but, of course, their future vastly depended upon their investments in the two other companies. They would see from the report of the Edison and Swan Company that they had very good prospects, and that the sale of the lamp was increasing from day to day. Electric lighting was now alive, and there were companies now at work who were risking enormous sums of money in every kind of device to give London the benefit of electric lighting; with their lamp, they would be the first to gain by that, because without them they could not light. It therefore seemed to him that the future was very hopeful, and he thought that in a very few years the shareholders would be amply repaid in both companies for the patience they had displayed.

Mr. F. R. Leyland seconded the motion.

A Shareholder asked how many years the patents had to run on the Continent?

The Chairman: About four and a half or five years.

A Shareholder said that a report was current that a lamp had been invented which was likely to compete with the incandescent lamp, and he desired to know what effect that would have on them.

The Chairman replied that almost every week since the Company had been in existence they had been threatened with a new lamp. He was not aware of anything except the rumour with regard to a new lamp by Mr. Edison. He would be delighted to hear that that was true, if it was patented, because in that case he would be bound to give them the benefit of the patent. He, however, did not believe the rumour, because Mr. Edison was interested in the Edison and

Swan Company to the extent of 117,000 deferred shares, in respect of which he could not get a farthing until they had 7 per cent. on their shares, and he did not think Mr. Edison would injure his own property.

The resolution was then put and carried unanimously.

The **Chairman** next moved: "That the following dividends be declared for the year ending September 30, 1889—viz., a dividend of 6 per cent. per annum on the amount of £3. 10s. per share, being the amount which has been paid on the partly-paid shares, and of 5 per cent. on the fully-paid shares, and additional dividend of 1 per cent. on the fully-paid shares, reckoned, for the purposes of this additional 1 per cent., as if £3. 10s. only had been paid on each of such fully-paid shares."

The motion was seconded by **Mr. Leyland**, and agreed to.

After the re-election of Mr. J. S. Forbes and Mr. E. W. Batt as Directors of the Company, and the appointment of the Auditors, a vote of thanks was passed to the Chairman and Board, which terminated the proceedings.

NEW COMPANIES REGISTERED.

Batava, Limited.—Registered by Baker and Nairne, 3, Crosby-square, E.C., with a capital of £100,000 in £1 shares. Object: to adopt an agreement made between Walde Salomonski and Morris Leopold Fillner, both of Nijmegen, in the province of Guelderland, Holland (trading as W. Salomonski and Co., at the Fabrick Batava, Nijmegen) and Charles Scott on behalf of the Company; to carry on in Holland and elsewhere the business of manufacturers, importer and exporters of, and dealers in margarine, butter, cheese, and any animal, vegetable, and other substance requisite or useful for the manufacture of margarine, or any other substitute for butter; and also the trade of cask, jar, and bottle makers, farmers, dairymen, ice merchants, tinsmiths, water works' proprietors, electricians, electrical engineers, supplies of electricity and of the electric light, and any other business incidental to or arising out of, or which can be conveniently carried out in connection with such businesses. The first subscribers are:

	Shares.
W. Salomonski, Nijmegen, Holland	1
C. Scott, Osterhills, St. Albans	1
J. Gardner, 81, Gracechurch-street, E.C.	1
H. S. Lidstone, 37, Great Tower-street	1
J. A. Gardner, 81, Gracechurch-street	1
A. H. Boxall, 37, Great Tower-street	1
S. B. Wiatt, 37, Great Tower-street	1

There shall not be less than three nor more than eight Directors. Qualification, £500. The first are H. S. Lidstone, E. Morris, F. Mason, A. R. Dyer, C. F. Huffam, D. Evans, E. S. Boord, and W. Salomonski. Remuneration to be declared at the statutory meeting.

Lange and Co., Limited.—Registered by Bonner, Wright, Thompson, and Co., with a capital of £10,000 in £50 shares. Object: to acquire the business of Lange and Co., Boulogne-sur-Mer, and to construct, establish, and carry on any works, machinery, and apparatus for lighting streets, public and private buildings by electricity. G. H. Verity and F. M. T. Lange are appointed the first Directors—F. M. T. Lange to receive £250 and 10 per cent. of profits after 10 per cent. dividend. The remuneration of other Directors to be determined in general meeting. Qualification, one share.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The traffic receipts for the past week amounted to £5,204.

Change of Address.—The publishing offices of *Electrical Plant* have been removed to 39, Queen-street, E.C.

West India and Panama Telegraph Company.—The receipts of this Company for the half-month ended November 15 were £2,841, against £2,319. The July receipts, estimated at £5,209, realised £5,225.

Western and Brazilian Telegraph Company, Limited.—The receipts of this Company for the week ended November 15, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,714.

PROVISIONAL PATENTS, 1889.

NOVEMBER 11.

17930. **Improvements in incandescent electric lamps.** John Henry Tucker, 128, Victoria-road, Aston Manor, Birmingham.
17974. **Improvements in apparatus for welding by aid of electricity which improvements are also applicable for other purposes.** Henry Harris Lake, 45, Southampton-buildings, London. (Hermann Lemp, United States.)

NOVEMBER 12.

18004. **Improvements in incandescent electric lamps.** Robert Alexander Sloan, 26, Castle-street, Liverpool. (George Warren Wilson and Charles Henry Brown, United States.)
18010. **Improvements in lamp fittings for electric lighting.** Illius Augustus Timmis, 2, Great George-street, London. (Complete specification.)

18005. **Improvements in electro-magnets for electric signalling apparatus.** George Bowron, 145, Maida-vale, London.

18018. **Improvements in electro-magnetic brake and traction increasing system.** Alfred Julius Boulton, 323, High Holborn, Middlesex. (Elias Elkan Ries and Albert H. Henderson, United States.) (Complete specification.)

18028. **Improvements in moulding plates for electric accumulators.** Ernest de Pass, 68, Fleet-street, London. (La Société Jacquet frères, France.)

18051. **Improvements in and relating to electric signalling apparatus, chiefly designed for use in hotels and other buildings.** Henry Harris Lake, 45, Southampton-buildings, Middlesex. (Frank Edward Morgan, United States.) (Complete specification.)

18067. **Improvements in the manufacture of secondary batteries or accumulators.** Albert Berwick Cunningham 4, South-street, Finsbury, London.

NOVEMBER 13.

18110. **Improved winding of armatures of dynamos.** John Farquharson, Woodlands Cottage, High-street, Acton.

18112. **Improvements in the metal sheathing of electrical cables.** Henry Edmunds, of the firm of Walter T. Glover and Co., 47, Lincoln's-inn-fields, London.

18146. **Improvements in electric meters.** Joseph John Tylor, 115, Cannon-street, London.

18159. **Improvements in electric contact-apparatus.** Christian Weuste, 45, Southampton-buildings, London.

NOVEMBER 14.

18172. **Improvements in china or porcelain electric light fittings.** John Henry Tucker, 128, Victoria-road, Aston Manor, Birmingham.

NOVEMBER 15.

18261. **Improvements in and relating to the construction of joints for telegraphic, telephonic, and like wires.** Robert Joseph Hooper Rastrick, 27, Bow-lane, Cannon-street.

18269. **Improvements in or appertaining to electric motors.** William Phillips Thompson, 6, Lord-street, Liverpool. (Ludwig Gutmann, United States.)

NOVEMBER 16.

18340. **Improved means of insulating electric conductors.** Robert Punshon, Albert Hindson Miller, and William Muir, 115, Cannon-street, London.

18350. **Improvements in dynamo-electric machines.** John Hubert Davies, 13, Cowper's-terrace, Grays, Essex.

18355. **Improvements in secondary generators, transformers, or converters of electricity.** John Dixon Gibbs and Emile Fesquet, 47, Lincoln's-inn-fields, London.

18360. **Improvements in dynamos.** William Robert Renshaw, 24, Southampton-buildings, London.

18361. **Improvements in electric meters.** Sebastian Ziani de Ferranti, 24, Southampton-buildings, London.

18362. **Improvements in electric locomotives and other variable speed electric motors.** Sebastian Ziani de Ferranti, 24, Southampton-buildings, London.

SPECIFICATIONS PUBLISHED.

1888.

17964. **Electric generators.** Siemens Brothers and Co., Limited (Taylor). 6d.
18636. **Electrical accumulators.** Fuller and Fuller. 4d.
18659. **Electric motors.** Siemens Brothers and Co., Limited (Taylor). 8d.
18981. **Electrical storage batteries.** Doubleday. 4d.

1889.

2082. **Telephone call boxes.** Thompson (Griffith and others). 8d.
6332. **Electric fuses.** Scott and others. 6d.
12390. **Electric motors.** Currie. 8d.
12418. **Insulating tubing for electric conducting wires.** Boulton (Cobb). 8d.
14666. **Electric conduits for street railways.** Reno. 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name	Paid.	Price Wednes- day
12 Feb.	1/2	Anglo-American Brush E.L.	—	4½
12 Feb.	2/0	— fully paid	—	5½
14 Nov.	0/4½	Con Telephone & Main ...	1	3½
27 July	10/0	India Rubber, G. P. & Tel.	10	19½
.....	...	House-to-House	4½	5
.....	...	Metroptn Electric Supply	—	3½
.....	...	London Electric Supply ...	5	4½
.....	...	Swan United	3½	5
2 July	12/0	Telegraph Construction ...	12	43½
2 July	6/0	— 6%, 1889	100	105
... ..	...	National Telephone	5	6½

NOTES.

Brussels.—The Senate at Brussels has been lighted by electricity by the Julien Company.

Belgian Exhibition.—It has been practically decided to hold a Belgian Exhibition in London next year.

Paris.—The inauguration of the Paris municipal station at the Halles Centrales will take place on December 1st.

New York Exhibition.—Half-a-million sterling has already been pledged towards a guarantee fund for the World's Fair in 1892.

Bucharest.—A concession for forty years has been granted to a local company for the public and private lighting of Bucharest.

Change of Address.—Messrs. S. F. Walker and Co., electrical engineers (late S. F. Walker and Olliver, Hunter's Forge, Newcastle), have removed to 92, Quayside, Newcastle-on-Tyne.

Ventilating Motors.—A "C & C" motor of 2 h.p. fitted to a Sturtevant blower capable of delivering 20,000 cubic feet of air per minute, has been fitted on the U.S. cruiser "Baltimore."

Nottingham.—The Town Council of Nottingham will take steps to apply for powers for supply of electric light, a small area in the centre of the town having been marked out for compulsory supply.

North Metropolitan.—Application is intended to be made to Parliament by the North Metropolitan Tramways Company for powers to use electricity for traction purposes on the whole of their system.

Reading.—Public notice has been given by the South of England House-to-House Electricity Company of their application for powers to supply electricity for public and private lighting in the town of Reading.

Edinburgh.—The minutes passed at the last meeting of the Edinburgh Town Council leave it open to the Lord Provost's Committee to either apply for power or to enter into arrangements with the electric lighting companies.

Leeds.—Two companies have given public notice of their applications for powers to supply electricity in Leeds—the Yorkshire House-to-House Electricity Company, 32, Park-row, Leeds, and the Electric Construction and Maintenance Company.

Lamps.—The Sawyer-Mann Company, of New York, are running night and day, and reports the demand so great that they are 100,000 lamps behind orders. A new pump-room is being added, and when this is completed they will have 900 pumps in use.

Electric Execution.—Another murderer, McElvaine, has been sentenced to electric execution, to take place on December 9. The German Emperor is said to be interesting himself in the question of introduction of electric execution in that country.

Derby.—The Corporation of Derby have given public notice of their application for a provisional order, with power, if thought fit, "to enter into contracts with companies or persons for the execution and maintenance of works and the supply of electricity."

Mechanical Regulation of Motor.—Dr. S. S. Wheeler has perfected an automatic governor for his motor, said to be creating a stir in electrical circles, which consists

in an arrangement which draws the armature out of the field of force while running at any speed or power.

Hastings.—The Hastings and St. Leonards-on-Sea Electric Light Company have given notice of their intention to apply for a provisional order for the lighting of the public streets, the Hastings and St. Leonards pier, and for general supply of electric current in Hastings and St. Leonards.

The late Walter Hall.—The death occurred on Friday last at his residence, 6, Pier-road, Erith, Kent, of Mr. Walter Hall, who had attained the age of 80. The deceased was a member of the Institute of Electrical Engineers, and had invented several electrical appliances. The illness was a brief one.

South Wales Engineers.—At a general meeting of the South Wales Institute of Engineers yesterday, at Cardiff, a paper on "Miners' Electric Safety Lamps," by E. T. Boston, was discussed, and a paper on "Large Incandescent Electric Lamps *versus* Arc Lamps" was read by Mr. Sydney F. Walker.

Telephony.—The South of England Telephone Company are just finishing an extension of their system at Deal, Kent, and the wire at Whitstable will be opened in another fortnight. The Ashford trunk line will then be commenced prior to the opening up communication between Maidstone, Chatham, and East Kent.

Long-Distance Compounding.—An installation has been carried out at the town of Cuxac d'Aude, which is over 1½ miles from the central station at Raonel, which is interesting on account of the distribution being by direct current at that distance. The dynamo is over compounded in such a way that the increase of potential with increase of current corresponds with the loss in the cable.

Aluminium Arc Lamps.—The cheapening of aluminium has led to the proposition to construct arc lamps of this material, as preferable, on account of its lightness and qualities of resisting rust, to iron, steel or brass for outdoor use. In reference to this it may be noticed that it is stated the American manufacturers have definitely decided to adopt the spelling "aluminum" instead of the longer name.

Electric Traction.—Sundry advertisements are appearing in daily and financial papers anent the Electric Traction Company's successful running with their storage cars of the line at Canning Town. Now this line is in full working order, the directors of the syndicate are doubtless conscious of power to successfully develop their work in other and larger directions—and, in short, we may hear more before long.

Electric Drug Grinder.—A triturator for grinding drugs has been ingeniously fitted up to work by electric motor, to save labour in chemists' shops or for drug grinders. The mortar or mortars to the number required are made to revolve by the electric motor, and a very heavy porcelain pestle hangs inside, the necessary grinding being assured by the revolving of the heavy pestle by friction against the inside of the mortar.

Electric and Steam Railway.—An enterprise which would be watched with much interest by both railway and electrical engineers, is under the consideration of Boston capitalists. It is proposed to build an electric railway from Boston to Salem, a distance of seventeen miles, and as the road would be in direct opposition to an existing railway, the capabilities of the two systems would for the first time be brought into active competition.

Harbour Lights.—Incandescent lamps on buoys, says *Engineering News*, are a practical success after one year's test in the Gedney's channel entrance to New York harbour. During the last nine months over 220 ocean steamers passed through the channel during the night, and not more than two lamps out of six were extinguished at any one time. Red glass globes did not last as long as plain ones, probably owing to the interception of a greater portion of heat. Red lamps are now used around clear glass lamps on all buoys.

Large Dynamos.—The fashion, or need rather, for large dynamos is spreading. There is nothing yet to compare with the large Ferranti dynamos, but the build is becoming larger and larger. Messrs. Siemens and Halske are constructing, for example, four dynamos, each of 1,000 h.p., capable of supplying current for 10,000 16-c.p. lamps, for the Berlin central stations. Electrical "engineering" is certainly now beginning to justify its name, and, moreover, must continue to invade other branches, until all engineering will eventually to a considerable extent be electrical engineering.

Electric Railway for Budapest.—It is proposed to build a new electric railway in Budapest, and it is expected that the decision of the Government will be in favour of the new system of Mr. Zipernowski. According to the correspondent of *Industries*, a few days ago the members of the Hungarian Institute of Engineers assembled in the large hall of Messrs. Ganz's works to hear the explanation of the new system and to inspect the plant. The novelty of the railway consists in the method of switching the cars at junctions. The distributing leads are arranged under the road in a concrete conduit.

Station Indicator.—What is greatly desirable on some of our suburban lines and more than once proposed—an electric indicator of the names of railway stations—has been adopted on the Jersey Central Railroad, U.S. A step-by-step magnetic apparatus turning a roller on which are printed the names of stations in good visible letters is fitted over the window of every carriage, with an electric bell to call attention of passengers to the change. The instruments are connected in series, and are under control of the guard, who changes the names by a simple touch of a button before the train stops.

Long Distance Telephony.—The long distance telephone lines in America will by the 1st of January be complete across the continent from New York by Chicago and Denver to San Francisco. The opinion is expressed that in less than two years the Bell telephone will practically do away with telegraphing, and it is said that Jay Gould, recognising the change, is making as little improvement in the Western Union plant as possible. An expert of the latter company has said that in Boston and near by points, for anything like pressing business, the telephone already completely crowds out the telegraph.

Scotch Underground Railways.—Proposals are being made for a new underground railway between Edinburgh and Leith. As no underground railway would be undertaken without the consideration at least of methods of electric traction, there will be, if this proposal is carried out, another field for heavy electrical work. It is also understood that a Bill will be promoted next session for the construction of circular subways under the Clyde at Glasgow, to improve the facilities for rapid transit between the city and suburbs, and Messrs. Simpson and Wilson, of Glasgow, have been appointed the engineers to the scheme.

Windsor.—A special committee of the Windsor Guardians reported, with reference to the Windsor and Eton Electric Light Company's application, that they considered the company, with a nominal capital of £30,000, of which only £1,250 is subscribed and £764 paid up, was not in a position to carry out the supply, and that it would be unwise to grant a valuable concession to the company merely because it was first in the field. They advised the consent should be delayed till after the application had been made to the Board of Trade. The report was adopted.

Electric Pipe Lighter.—*L'Electricien* illustrates a self-contained electric pipe lighter, a neat and useful novelty, designed by M. Radiguet. It has a spiral of platinum placed away from the flame, so that it does not get consumed by use, and at the same time is placed where the mixture of spirit and air is most active. It is mounted on a small battery, the plates of which are fitted to a spring. On pressing the spring the plates descend, the wire is heated and lights the spirit, a small cap covering the wick being raised by the same action. This can be kept up by a knob if desired, but usually descends again when the spring is released.

Electric Signals in Workshops.—Mr. Barnett, in a paper dealing with the design and construction of railway shops in the States, mentions a point which will equally well apply to other large engineering shops, when he says: "For intercommunication, not only between the chief offices and foremen's offices, but also between shop and shop, and each bench and the tool room, electric bells, telephone service, and displayed signals, to call persons moving about through the works to the nearest telephone, are daily receiving more general adoption, and their usefulness is so marked that a single experiment with them is sure to result in their permanent use."

Who Will Furnish Light?—There is no use in the gas people thinking that they are the people to furnish light. For lighting purposes gas is as certainly doomed as the stage coach upon the appearance of the railroad. The province of gas in the future is to supply heat and not light, and if we are temporarily exposed to the comment of an indignant public, it is because we have builded according to the light we then had, and not always wisely nor well, and have been hampered too much by the ignorance of legislators or the importunities of stockholders, and have strained the capacities of individual lighting systems by placing them in positions for which they were not on the whole adapted.—*Dr. Leonard Waldo.*

Iron Armatures.—Something rather startling may be expected, if what we hear is true, in the development of dynamo building in the future. One prominent dynamo maker at least is said to be pinning his faith to the type of dynamo with iron-wound armature, having no copper whatever in its coils, of the kind we have heard something about both from Paris and from Berlin. Expressions are not wanting from those who believe in the iron armature to indicate that they consider iron will beat copper out of the market in armatures as it has in telegraph wires, and that in a few years the copper-wound article will be as extinct as the dodo. Anyhow, if this is too much to expect, we may not be far out in mentioning that developments may be looked for.

Houses of Parliament.—The satisfactory progress that is being made in distribution of electric light in London is well illustrated by the extension that has been decided upon in the lighting of the Houses of Parliament

Hitherto the lighting of a portion of the palace has been undertaken with their own plant by the authorities of the House, controlled by the First Commissioner of Works. It has now been decided to light practically the whole of the House, and it has been thought advisable to obtain the supply of electricity from an outside source. A contract has therefore been entered into with the London and Westminster Electric Supply Company, and active steps are being taken to carry it into effect. The dynamos in the basement of the House of Commons will consequently no longer be required, the current in future entering the building through a cable coming from the nearest station of the London and Westminster Company.

Carlisle.—The Corporation of Carlisle is one of those who early secured a provisional order enabling them to provide electric light in the city. The order was allowed to remain in abeyance, and it was suggested at a recent meeting that the powers had lapsed. The town clerk, however, expressed the opinion that the order had not lapsed, and that the powers conferred were perpetual. The Brush Electrical Engineering Company have announced their intention to apply for a provisional order to the Board of Trade, but the Corporation consider they have sufficient status already to deal with the case, to defend their position if necessary. Mr. Hepworth, manager of the Carlisle Gas Works, is preparing a report upon the state of electric lighting in other towns, which he intends to present to the Gas Committee. The opinion seems to be strong that the Corporation should be sole purveyors of light, gas or electric, in Carlisle, though they may delegate their powers to an electric lighting company on certain agreed conditions.

The late John Kaye Gray.—It is with extreme regret that we hear of the death of Mr. John Kaye Gray. The family to which Mr. Gray belonged is one whose members will ever rank high in the annals of electrical progress, and the gentleman who has passed away was not one of the least conspicuous. An earnest worker, a true comrade, with a disposition to make the best of everything, his loss will leave a blank among the workers at Silvertown that will be felt for many a day. Mr. John Kaye Gray was educated at University College School and on the continent. Subsequently, he joined the cable staff at Silvertown, and gained experience in actual work; then undertook the management of the French factory, with satisfactory results. Mr. Gray had been ailing for some time, yet his death at Mentone, at the early age of 33, was somewhat unexpected. The funeral took place at Wickham, and anyone who knew him will be glad to add their sympathy to that of his family in the bereavement they have sustained.

Fall of Overhead Wires.—It seems we are not going to leave America behind in the matter of falling electric wires, as an accident which occurred in Fleet-street on Monday showed, though fortunately no serious damage was done. One of the telegraph wires passing over Fleet-street diagonally from the corner of Chancery-lane to the south side of Fleet-street fell along the street nearly up to the Law Courts. Several persons were struck, and one gentleman received a bruise four or five inches long on the side of the neck. It is just such an accident as this which has too often proved fatal in America. Happily, there were no electric light wires underneath, and if there had been, in England they would have been well insulated; but if this accident had happened in New York the wire would, if we

may judge from recent reports, most likely have fallen on a cheaply-insulated electric light wire, made contact and possibly have killed the unfortunate gentleman. The faults of the telegraph wire, however, do not here lead to unsparing odium for the whole electric lighting business, and we may congratulate ourselves that in all probability the failure of an overhead wire will never lead to anything much more serious than a bruise.

Woodhouse and Rawson.—Messrs. Woodhouse and Rawson, Limited, have now entirely removed from their well-known premises aloft in 11, Queen Victoria-street, and they have entered bag and baggage into No. 88, opposite the Mansion House Station. The whole house has been taken, and a fine place it makes. The ground floor serves as stock and show room, the first floor as general offices and board-room, and the second floor as contract department. Arrangements are still in progress, and settlement has not yet quite arrived, but business seems to be briskly proceeding notwithstanding. The basement, which serves as packing and storeroom, has two cellars fitted up with an installation, consisting of a dynamo driven by a Stockport gas-engine and a battery of 53 storage cells, arranged in a remarkable strong, neat, and serviceable manner. The installation will supply light to the premises and show fittings, and has been carried out under the superintendence of Mr. Reginald Jones, the company's contract manager and engineer, who reports work busy all over the country. The new departure is certainly a great improvement, and will doubtless result in easier handling of the large business which is setting in from the present developments of electrical work in all directions.

Barnsley.—A special meeting of the Barnsley Town Council was held last Friday, the Mayor (Ald. Wood) presiding, to consider the following recommendation of the Park and Lighting Committee: "The committee recommend that application be made to the Board of Trade for a provisional order authorising the Mayor, aldermen, and burgesses of the borough of Barnsley to erect and maintain electric works and lines and to supply electricity within the said borough." Mr. Wray moved the adoption of the recommendation. Considering the action of the gas company and the defiant manner in which they had met the burgesses of the town, he thought it was time action was taken by the ruling body of the borough to do away with the monopoly under which they suffered. Ald. Brady seconded the resolution, which was passed. The petition from gas consumers, asking the Council to apply to Quarter Sessions for an investigation of the books of the gas company, with a view to see if they had done anything outside their Acts of Parliament to the prejudice of the consumers, was considered. Mr. Wray moved its reference to the Lighting Committee. Ald. Brady, in seconding the motion, pointed out that Quarter Sessions could only enquire whether the dividend of last year was excessive, and pointing out how, in equity, the consumers ought not to be charged with the burden caused by the excessive and unnecessary expenditure which the gas company had incurred, and with the heavy burden of interest charged on them, urged the importance of a full and complete enquiry. The motion was carried.

The Edinburgh Exhibition.—A meeting of the London Committee recently formed in connection with the forthcoming International Exhibition of Electrical Engineering, General Inventions, and Industries, at Edinburgh, was held last Monday at the Mansion House. The Lord Mayor

(Sir H. A. Isaacs) presided. A deputation from Edinburgh attended. Sir George H. Chubb, the chairman of the London Committee, said that, from the number of persons of eminence and distinction who had consented to join the committee, there could be no doubt that the metropolis and the South of England generally would be well represented. Mr. S. Lee Bapty, the general manager of the exhibition, speaking from experience of other similar undertakings, said the prospects of the exhibition were extremely favourable. The buildings were well under way, and the applications for space were very satisfactory. Foreign nations would be remarkably well represented. Mr. G. E. Watson, the secretary of the exhibition, added that the guarantee fund amounted already to £23,000, and the building would cost £35,000 or more. The exhibition will be open from May 1 to November 1, and applications for space would be received until 1st January next. Mr. C. M. Kennedy, C.B., of the Foreign Office, moved a resolution commending the exhibition to the support and co-operation of the public. Sir Lyon Playfair, M.P., seconded the resolution, which was carried, and, at the instance of Captain Shaw, C.B., a sub-committee was appointed. The Lord Mayor, replying to a vote of thanks, intimated his intention to pay a visit to Edinburgh, not only to see the exhibition, but to remedy the omission of his predecessors, who had never yet visited Scotland in civic state.

Birmingham.—The agenda for the next meeting of the City Council contains the following notices of motion on the subject of the lighting of courts: Councillor Granger intends to move: "That it be an instruction to the Public Works Committee to take into immediate consideration the question of lighting the courts and terraces of the city, so as to secure the lighting of all such courts and terraces not at present lighted; and also to consider the advisability of putting into force the existing statutory powers set forth in the town clerk's report on this subject presented to the Council on February 1, 1887." Alderman Powell Williams has given notice to move: "That the General Purposes Committee be requested to report to the Council what alteration in any local Act or Acts would be necessary in order to empower the Corporation to enter the various courts of the city for the purpose of lighting the same, without incurring responsibility beyond the supply and maintenance of the necessary lamps, fittings, and means of lighting, and whether the necessary change in the law could be obtained by the inexpensive method of a provisional order." Councillor Jarvis has given notice to move: "That it is desirable, in the interests of the health and comfort of the inhabitants of the courts and terraces within the municipal area of the city, that the said courts and terraces should be lighted at the cost and under the control of the city authorities. That, in view of the difficulties that would arise in carrying out this proposal, as pointed out by the town clerk in his reports to the Council on February 1, 1887, and July 3, 1888, it be an instruction to the Public Works Committee to consider the matter, and report as to the best means to be adopted to secure the above object without declaring the courts and terraces public highways or streets."

Dissociation of Electrolytes.—An abstract of a paper by W. Ostwald on this subject appears in the current issue of the Chemical Society's *Journal* to the following effect: Some of the phenomena which accompany the formation of salts in solution are explained by the author on the dissociation hypothesis. When an acid and a base,

each in dilute solution, are mixed, since in each, as likewise in the resulting salt, the ions are in the state of dissociation, no change in the condition of the metal or the non-metallic radicle will take place, but the sole alteration will be the combination of the free ionic hydrogen of the acid with the free ionic hydroxyl of the base to form water. Combination, therefore, does not, as formerly supposed, take place between the metal and non-metallic radicle, but only between the hydrogen and the hydroxyl, and to this one reaction must be referred all the phenomena accompanying the neutralisation of an acid by a base in solution. The fact that the heat of neutralisation of all acids is the same is thus easily explained, since in all cases only one and the same reaction occurs. The heat of neutralisation is, in fact, the heat evolved by the combination of ionic hydrogen with ionic hydroxyl, to which, in case the acid or base is not completely dissociated, must be added or subtracted the heat necessary to effect complete dissociation; this last is, however, in most cases inappreciable. From the above it also follows that the addition of a solution of one salt to that of another will be unattended by a development of heat, since in each, both before and after mixture, the ions are in a dissociated state. The displacement of a weaker by a stronger acid in a salt is due, not to the attraction of the metal for the non-metallic radicle, but to the attraction of the hydrogen of the stronger for the negative radicle of the weaker acid, combination between these two taking place, since a weak acid dissolves with little or no dissociation. The author also considers apparently abnormal reactions between salts in solution, and shows that in all cases the reactions are only such as occur between the ions into which the dissolved salts are dissociated. A true double salt is defined as one which, on dissolving, is dissociated into the ions of the salts of which it is composed.

The Electric Tachyscope.—The instantaneous pictures of horses and other figures which have been exhibited at the Royal Society and elsewhere, have both given a great impetus to instantaneous photography, and have added to our knowledge of moving figures. The systems of reproducing these pictures before audiences have been usually adaptations of the old zoetrope principle. Mr. Ottamar Anschuetz, of Lissa, Prussia, has adopted the instantaneous flash of electric discharge to show these pictures, and illustrations of his apparatus and methods are given in the *Scientific American* for Nov. 16. Mr. Anschuetz's process of taking the negatives is itself a great improvement upon previous methods, and depends upon the use of a new slide shutter. This has a narrow slit as long as the plate, which passes rapidly over the face of the negative, exposing successive portions. This arrangement produces negatives extremely sharp in the details. The exhibiting apparatus, the "tachyscope," consists of a revolving wheel with a series of these pictures mounted on its periphery. Behind this wheel is a box containing a spiral Geissler tube. Studs projecting from the wheel are arranged in connection with the contact breaker of a Ruhmkorff coil, so that every time a picture comes before the Geissler tube it is illuminated by an electric discharge through the tube. This discharge being instantaneous shows each picture in an apparently fixed position, and these pictures succeed each other so rapidly that the retinal image of one picture is retained until the next is superimposed upon it, thereby giving to the observer the sense

of a continuous image in constant motion. A horse jumping a hurdle is a favourite picture. Many positions taken by the horse, as well as by the rider, are truly surprising. The ancient Greeks seemed to have had a more accurate power of vision than modern artists. A relief on the Zeus Temple in Olympia shows a wild prancing horse standing on one of its hind legs. Modern artists always represent prancing horses standing on both hind legs. In many of Mr. Anschuetz's pictures we find prancing horses standing on one leg, as represented in the ancient statuary. The positions taken by an acrobat in leaping through the air are very curious.

Central London Railway.—A good deal of very perverse opposition may be expected to the Central London railway scheme, but it is a thing that ought and probably must come before long, to ease the crowded streets. The Commissioners of Sewers started a motion to oppose it, but this was set aside, and the question referred to the Streets Committee. The tradesmen along the Oxford-street route will probably be those who present the most determined opposition. They both fear for their houses and also for their custom. They do not wish to see the roads taken up, nor do they wish to see diminution in the crowded streets. They love crowded streets, and if persons can be whisked by underground express in 10 minutes from City or Piccadilly to Shepherd's Bush they will not, the shopkeepers fear, walk along Oxford-street and so be tempted to buy. In the last of these suppositions they are probably as far from need of fear as the first, as better communication will bring more buyers from the suburbs. The railway, instead of being just below the surface, and involving excavations, will be carried out at a considerable depth, 40ft. or 50ft. below surface, through the bed of stiff London clay. The tunnels will be pierced through first by means of steel tubes 11ft. in diameter, the interior will be excavated and then lined with plates of iron, the two tunnels thus being formed of two immense iron pipes running side by side. The construction of these tunnels would be carried out in the same way as already successfully accomplished with the Southwark Subway, of which line it is to be, in effect, a continuation. The engineers to the scheme are Sir John Fowler and Mr. Benjamin Baker, of Forth Bridge fame, acting with Mr. Greathead, who is already, it will be remembered, engineer to the Southwark Subway. The line will be well ventilated from the stations, and there will be none of the objectionable blowholes of the present underground railway. The motive power proposed being electricity, there will only be the natural ventilation to provide for, the noxious fumes of the steam locomotives being, of course, entirely absent. The stations proposed are at Queen's-road, the Marble Arch, Oxford-circus, Tottenham-court-road, Southampton-row, Holborn-circus, the General Post Office, the Royal Exchange, and the Monument, where the line will join on to the Southwark Subway. The access to the stations will be by hydraulic lifts from the street surface, as already provided on the Southwark line.

Tests at Deptford.—Work has been progressing satisfactorily at the Deptford central station, with the testing and setting to work of the large 45ft. dynamo and engine, and some particulars of what has been actually done will no doubt be interesting. The technical press have not given much information upon the progress of the work lately, and the engineers have been (as they have

all along) silent, unless when asked, content to let the facts speak for themselves. But it is amusing to remark, in the absence of anything definite, what ridiculous and absurd rumours the average City man believes and spreads forth upon this gigantic enterprise, which is now making itself felt as a power in the land. Two little tales we have heard, which we may repeat—with their origin—for the amusement of our readers. The first of these is that "Ferranti's big dynamo—something seriously the matter, you know—it can't be got to excite itself at all, it is said!" This is the outcome of the information given to a certain contractor of varied but superficial knowledge, and considerable curiosity, by one of the Deptford engineers, "That the Ferranti dynamo was not a *self-exciter*." The second little tale is like unto it. "Mr. Ferranti," it is said, "is going to give up distributing his alternate current, and will run a large alternate-current motor at Charing Cross to drive another direct-current dynamo to supply the lamps (!) and charge accumulators" (!!). This is the outcome of a remark that the company would not eventually transform at Charing Cross, but would transmit the current *direct* to the Grosvenor. After all this, it may be well to give a little information of what has actually been accomplished. The first engine and dynamo at Deptford, of 1,250 h.p., has now been running off and on for about a fortnight, supplying light to Charing Cross and occasionally supplying current for several of the Grosvenor circuits. The engine has been run some time without load for the purpose of getting its large working parts into good condition—in large engines always a matter of time at first. Afterwards, the dynamo was run, first without current and then with current, and tested by resistance coils at the works. Tests were then made of the main cable, and current was transmitted from the Grosvenor to Deptford. On Thursday, Nov. 7, the first transmission of current from Deptford to London took place. The dynamo was run at 5,000 volts, with half the full exciting current. The high-tension current was transmitted to the Adelphi arches, Charing Cross, and there converted, first to 2,400 volts, and then, by means of another transformer, to 100 volts in the usual way, and 60 lamps were lighted for some time. The potential as measured on the voltmeter at Charing Cross on the lighting circuit was 100 volts, the potential as measured by means of a similar Cardew voltmeter connected to an exactly similar converter at Deptford was also 100 volts, so that no appreciable loss was noticed. Of course there may have been a loss of as much as 10 volts in the 5,000-volt circuit, but this would be only 0.2 per cent., which is too small to read on the 100-volt circuit. Other runs have been made in the same way. On Monday, November 18, the dynamo was again run at 5,000 volts. The current was converted to 2,400 volts at Charing Cross, and then sent to the Grosvenor, where it was connected on to two or three of the Grosvenor circuits, being, of course, converted again to 100 volts at the customers' houses. Two trials were made. The first was for an hour, and 23 amperes were transmitted. In the second, 43 amperes were transmitted an hour afterwards. This latter corresponds roughly—at 72 10-c.p. lamps to an ampere at 2,400 volts—to about 3,000 10-c.p. lamps. It is evident that these tests are of an eminently practical nature. The dynamo has given no serious trouble, and has turned out better even than was anticipated. No difficulty has been found with the insulation, which has been tested up to an equivalent of 40,000 volts with an induction machine, before running.

THE CENTRAL STATION OF THE HALLES CENTRALES AT PARIS.

The first central station for the public supply of electricity in Paris, established at the Central Markets, is now complete, and is to be officially opened very shortly. Our contemporary *L'Electricien* gives details of this new central station, which is interesting from more than one point of view, and will prove the starting point of a vast change in the lighting of the gay city.

Boilers.—The boilers are six in number, of the Belleville type, each supplying 1,500 kilog. of steam per hour, and each capable of being cut off from the main steampipe. They are placed in a passage parallel to the engine-room, from which they are completely separated. They are worked at a pressure of 15 kg. per square centimetre (about 90lb. per square inch). Steam reducers are placed to reduce the pressure to that required by the different engines.

Engines and Dynamos.—The dynamos are of two types, and the engines to drive them are also of two different

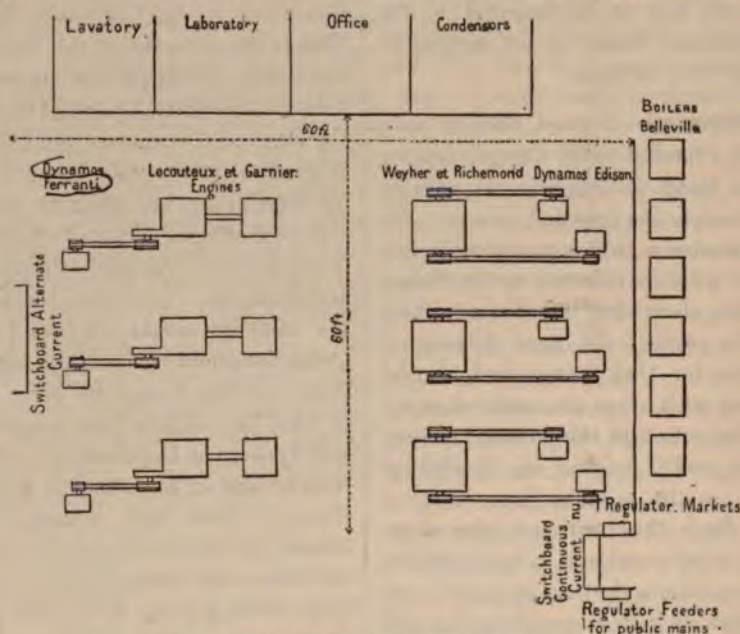


FIG. 1.—Plan of station, showing disposition of machinery.

Purpose.—The municipal central electric station of the Halles Centrales, which has been erected by virtue of the resolution of the Municipal Council of July 27, 1888, is established primarily for the purpose of testing actual methods of electric lighting and to keep account of the price of maintenance, in order to counteract any exaggerated speculation on the part of the electric light companies who have obtained concessions in Paris. It will be employed at the same time to light the Central Markets,

and kinds. The six continuous-current dynamos are driven, through belting, by three Weyher and Richmond triple-expansion engines, of 100 kilowatt power, working at 10 kilogrammes per square centimetre (55lb. per square inch), and consuming 21lb. of steam per kilowatt hour. The alternate-current dynamos, three in number, are driven by rope gearing, each by a Lecouteux and Garnier single cylinder horizontal engine of 125 kilowatt power, running at 180 revolutions per minute.

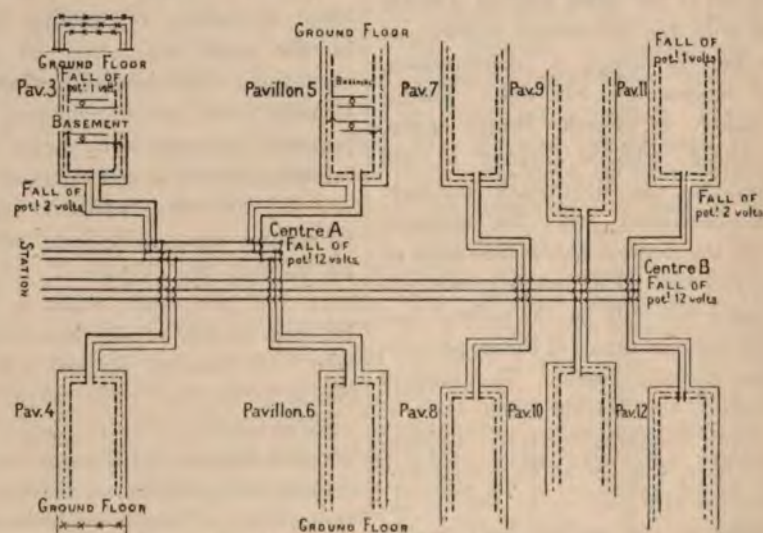


FIG. 3.—Lighting of the Markets.

the adjacent streets, the Rue de Petits Champs, the Avenue de l'Opera, and the neighbouring boulevards. The distribution will be effected by continuous current at low pressure in the district adjoining the Markets, and by alternate currents at high tension in the districts further away.

Situation.—The station, whose entrance is in Rue Vauvilliers, is situated in the Central Markets in the basements of pavilion No. 3. The present machinery only occupies about one-third of the site provided. Fig. 1 shows the general plan of the installation,

The continuous-current dynamos are Edison machines of 110 volts and 450 amperes, running at 600 revolutions. The alternate current dynamos are Ferranti machines working at 2,400 volts, and giving 50 amperes at 500 revolutions per minute.

Continuous-Current Distribution.—The low-tension distribution is effected by the three-wire system with feeders. The dynamos are coupled two-and-two in series, and the three groups thus formed are connected in parallel to the distributing circuits. The cables from these groups are

led to an "inverter," and from this inverter three heavy copper bars go to the main distributing-board, Fig. 2, to which the feeders are also connected; these latter are connected in parallel to the distributing bars through the ampere-meters and the slide-bolts of the main switches. Leaving the switchboard, the feeders divide into two groups—one going to the switchboard for the Central Market lighting, and the other to the switchboard for the public streets, placed to right and left of the main switchboard.

Lighting of the Markets.—The ten pavilions of the markets (numbered 3 to 12) have been divided into two groups, the first comprising Nos. 3-6, and the second Nos. 7-12. The feeders going from the Market switchboard end at A, radiating to supply the first group, and at B to supply the second group. Test lamps placed on the switchboard, and fed direct from the centres A and B, serve to notify any difference of potential at these points, which is maintained constant by means of resistances.

Groups of three wires, therefore, go from the centres of distribution, A and B, each to a small switchboard placed in each pavilion, and from these smaller switchboards lead off all the lamp circuits. The arc lamps are placed four in series on the 220-volt circuit. Their number and candle-power varies with the importance of the pavilions. The total number of arcs is 170. Besides this, two other circuits go from the small pavilion switchboards, at 110 volts, for supplying 450 incandescent lamps, fitted in the basements. These lamps are divided into two circuits, because some are required to burn constantly and others only intermittently.

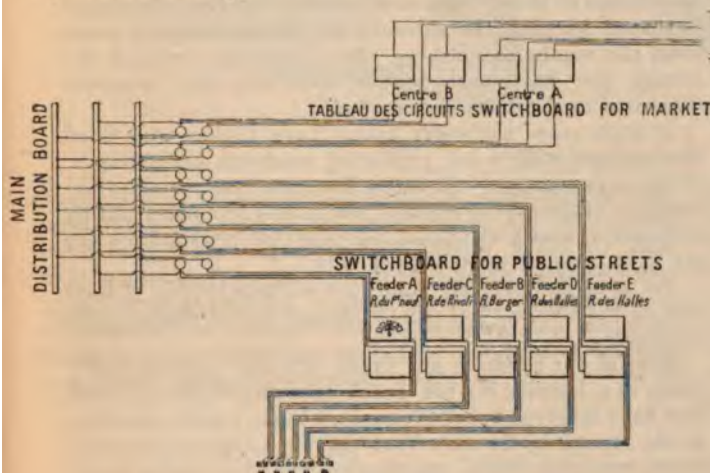


FIG. 2.—Diagram of Distributing Switch Boards.

Lighting in the Public Streets.—We have seen that a certain number of feeders, 15, go from the main distributing-board to that of the public streets. There (Fig. 2) the feeders, which are respectively at the potentials 0 and 220 volts, traverse the resistances, and then continue with the others, and end at the different points of the distribution mains (Fig. 4); test wires connected at these points allow the difference of potential to be read at the station. The figures marked on the diagram (Fig. 2) indicate the section of the cables in square millimetres; they have been calculated so that the fall of potential should be one volt at the maximum on the distributing circuits and 15 volts on the feeders. The power at present at disposal for the public streets is 100 kilowatts, and mains have already been laid in the rues Berger du Pont-Neuf, de Rivoli et des Halles.

Regulation.—The regulation required consists, in the first place, in maintaining a constant difference of potential between the extreme bars of the main switchboard by a proper exciting current in the dynamos, and, secondly, in maintaining the difference of potential constant and equal at the extremity of all the feeders by varying the resistance of the resistances placed in each circuit. The fall of potential produced thus by each feeder is 15 volts.

Mains.—The cables are placed beneath the pavement of the street. To cross the larger streets, galleries and man-holes which reach the depth of 22ft. have been obliged to be built. The cables for lighting the markets are insulated first by a serving of cotton placed directly upon the copper

core, then by two coats of pure rubber, three coats of vulcanised rubber, two servings of rubber tape and braiding outside. These have been made by the India Rubber, Gutta Percha, and Telegraphs Works Co., at their works at Persan-Beaumont, in France, superintended and tested by M. Jacquin, controller of telegraphs, and M. J. Laffargue. The average conductivity has been found to be over 100 per cent. of so-called pure copper, and the insulation resistance has varied between 3,000 and 6,000 megohms per kilometre. The mains for the public streets were supplied by the firm of Menier et Cie., and laid in the same way as the feeders. They are practically the same in manufacture as the foregoing.

Total Cost.—The total cost is given at 1,000,000f. (about £41,000), of which the six Belleville boilers are 74,500f., the three Weyher and Richemond engines 100,000f., the three Lecouteux and Garnier engines 76,500f., the three Edison dynamos 43,665f., the three Ferranti dynamos (Patin) 96,050f., the fittings and the lamps on the markets 8,500f., the cables and subways 27,500f.

Price to Customers.—The electric energy is supplied to a meter in each case, according to the police regulations drawn up by the Prefecture of the Seine, at the price of 15c. (7½d.) per 100 watt-hours, with a reduction proportional to monthly consumption as registered by the meter.

Conclusion.—This short description of the municipal station at the Halles will suffice to show that if central stations are established but slowly in Paris, they could not be better done. The city of Paris has neglected nothing

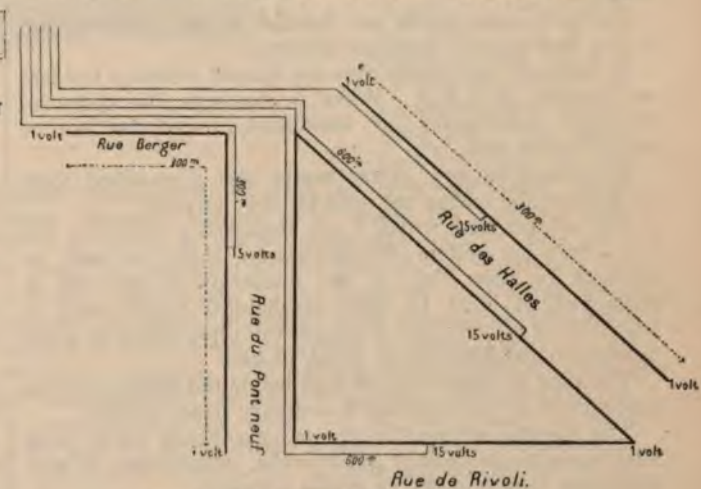


FIG. 4.—Lighting of the Public Streets.

to make its first station serve as a model, and it has certainly fully succeeded. It has been carried out under the superintendence of a technical committee, consisting of MM. Guichard, Lyon-Alemand, Jacques, Dumay, Paulard, Gaston Carle, and Levraud, municipal councillors; and MM. Mascart, Potier, Hospitalier, and Carpentier, delegated by the syndicate of master electricians and a delegate of the chamber of working electricians. M. F. Meyer, engineer of bridges and roads, has drawn out the plans and has been entrusted with their execution, and by the ability of this eminent engineer, the numerous difficulties which presented themselves in the erection of a central station in the centre of such a stirring part of the city have been easily overcome. He has had as assistants M. Chrétien, conductor of bridges and roads, who has already installed the electric light in the Hotel de Ville, and M. J. Laffargue, late student of the School of Physics and Chemistry, at Paris, who has calculated and drawn out the entire system of electric distribution. M. Darche has superintended the construction of the buildings and the fixing of the machinery.

CONDUITS AND CABLES.

BY DAVID BROOKS.

Conduits for underground electrical conductors are generally supposed to facilitate the construction and repairs of an underground system, but such is not the case, as I will endeavour to show

Nothing that is drawn in can long withstand the damp and confined atmosphere of a conduit, mixed as it is with sewer and illuminating gases. If the conduits are made of wood, the acid coming from the wood itself contributes to the process of disintegration and decay.

When a cable or conductor in a conduit fails, in nine cases out of ten there are no cables or conductors ready to supply the place of the one pulled out, and it is necessary to wait for one to be manufactured.

This is the "draw-in and draw-out" system.

The Edison is different, and cannot be pulled out and replaced by another conductor; but the fault, when it occurs, is local, and can be located to an inch, and remedied in as short or less time than it takes to get ready to pull a cable of 500ft. in length out of a conduit.

The Edison Company in this city have located and removed or repaired over 300 faults due to original bad construction rather than to the system itself.

By the laws governing the currents the defective spot is ascertained, the earth above it removed, and the cable or conductors repaired.

The manner of locating faults with such exactness is known as the "loop test," and the process is well described on page 226 in Culley's Handbook, eighth edition, and also by Kempe, under the head of "Murray's Loop Test," by which is found the sum of two resistances and their differences. Subtracting the difference from the sum, half of the remainder is the resistance of the shorter length, which, again deducted from the sum, gives the resistance of the longer length. The resistances are proportional to the lengths.

Faults in ocean cables are located by this means within a very few miles or fractions of a mile.

In ordinary city limits they are located within a few feet or fraction of a foot. When it comes to the distances between splice-boxes or handholes, the defect can be located to an inch.

A portable battery, galvanometer, and a modified form of Wheatstone bridge are used for this purpose.

The system with which I am identified is a draw-in but not a draw-out system; for this reason, there has been no occasion to draw out. If the insulation is impaired or destroyed, it must be from mechanical means, such as breaking or injuring the wrought-iron pipe, which is proof against an accidental blow of the picks.

The pipe is placed far enough below the surface of the ground not to be disturbed in ordinary street repairs.

The material within the pipe is hermetically sealed from such agencies as destroy guttapercha, indiarubber, or anything else that is of the vegetable kingdom.

The oil we use in a pipe is a pure distillate, and no product of distillation undergoes change except for the better when confined in air-tight vessels. Thus there is no deleterious change.

As before stated, the Brooks method is not a draw-out system, for the reason that there is no necessity. But 1,000ft. of cable can be drawn out easier than 500ft. could be drawn from any conduit system, because the former is lubricated inside the pipe. If perchance the insulation becomes impaired, as stated, it must be from some damage done to the pipe enough to expose the conductors, as a mere hole in the pipe will not admit moisture, because the oil is much heavier than water. The defect must be local, and its position can be readily determined, as before explained, and a pipecutter, with a few feet of cotton-covered wire, can easily repair the damage. On the other hand, when a fault is detected in a cable that has been drawn into a conduit, every portion of it shows serious disintegration. If a cable of our system is injured by mechanical means, the surface of the ground must be disturbed, which would be enough to indicate the exact spot of the "trouble" without the aid of the "loop test."

The effect of confined air, such as contained in a conduit, has been known in England for at least 30 years.

A patent was taken out to preserve the guttapercha covering on conductors by drawing the cables into iron pipes filled with water.

The English Post Office Department do this yet wherever it is practicable.

J. Hudson and Phillips adopted this plan in laying their

mains for electric light installations until latterly. Now they insulate with oil.

Telephone exchanges require large numbers of conductors of small diameter. Five hundred of these conductors properly insulated can be drawn into a 3in. pipe when oil is used. These conductors generally take one direction in getting from the basement of the exchange into the street. Suppose for that purpose a single pipe of large diameter is used, for instance, one of 15in.; the ends of the pipe bent upwards, in order to prevent the loss of oil. This pipe would have a capacity for 10,000 conductors, which could be drawn into the oil in groups of 100. I know of no method by which the insulation could be so well preserved.

Now, compare the cost of such an arrangement with the conduit system that has been in process of construction for the past six months, which, when finished, will be only a place for the reception of the conductors. Ten times as much money is spent in making a poor job as is necessary to make a good one.

When once in the street, the conductors would diverge and take opposite directions. Then two or more pipes of smaller dimensions could be used. Such a plan could be adopted as would accommodate the number of wires as they diverge in different directions.

Again, compare the cost of such an arrangement with that of some of the subways that have been constructed in New York City.

Philadelphia has more electrical conduits than all the other cities of the United States. There are as many as four in some of the streets. There are, however, very few conductors in them, but a new industry has been developed—that of keeping the subways in repair, pumping water from the manholes, cleaning them from the dregs of the sewers that have been broken open, and their contents deposited in the ducts and manholes.

In some cases the water mains have broken and filled the conduits with water, producing washouts and caving in of street pavements. Rotating fans are used to clean the conduits of the explosive gases, which also produce death by suffocation, nearly as instantaneous as that produced by the arc light currents in New York City.

We have had over 50 explosions in Philadelphia. I have this on the authority of one of our best posted electric light engineers.

Most of our conduits are made of wood, and the explosions, as a success, do not reach the magnitude of some that have occurred in Broadway, New York, where, according to the reports in the New York papers, a cast-iron manhole cover, weighing 300lb., was thrown over a four-storey building. The ducts of these conduits are made of wrought iron.

Conduits are expensive, and their construction a slow process, which interferes with the use of the streets. Large quantities of earth have to be carted away.

With the Brooks system the iron pipe occupies so small space, all the earth taken out is repacked in the trench. 2,000ft. of trench have been opened, the pipe laid, the trench closed, repaved, and cables drawn in, between seven in the morning and six o'clock in the afternoon of the same day, and no patching or levelling up of pavement required afterward.

It is stated that in laying conduits, extra ducts can be provided for future growth of business.

By the Brooks system, extra conductors, or a cable containing more conductors than required by the present need, can be drawn in by the one operation.

By the Brooks system, there are no vacant spaces for the collection of explosive and deleterious gases.

In proof of this article, it goes for something that the cable I laid for the Pennsylvania Railroad Company, containing 53 conductors, has worked for nearly three years without a moment's interruption to any of the conductors, although connected to overhead wires running to New York, Pittsburg, and Washington.

There has been no expense for repairs or maintenance except to paint that portion of the pipe running over the Schuylkill Bridge and along the elevated railway.

I especially call the attention of my friends here who have been so industrious during this time drawing out cables from conduits, and repairing the conduits themselves.

PAGET'S NEW ALTERNATE-CURRENT TRANSFORMER.

The modern construction which has been generally adopted for converters or alternate-current transformers, is one in which the magnetic circuit is entirely closed, there being no free magnetic poles. In this arrangement it is evident that the amount of magnetic material acted upon is always a fixed quantity so far, at least, as the primary circuit is concerned. While this arrangement leads to very high efficiencies at full loads—that is, when the converter is

of energy required in the secondary circuit in which the lamps are situated, and he accomplishes his object by varying the magnetic circuit in accordance with the load on the converter.

The accompanying engravings show one form of this new type of converter, Fig. 4 being a plan view showing the circuit connections of the primary and secondary circuits, and Figs. 2 and 3 respectively a side elevation and vertical section.

As will be seen, the converter is mounted upon two standards, S S', by means of an iron shaft, A, which is clamped tight in its bearings by means of the screws shown.

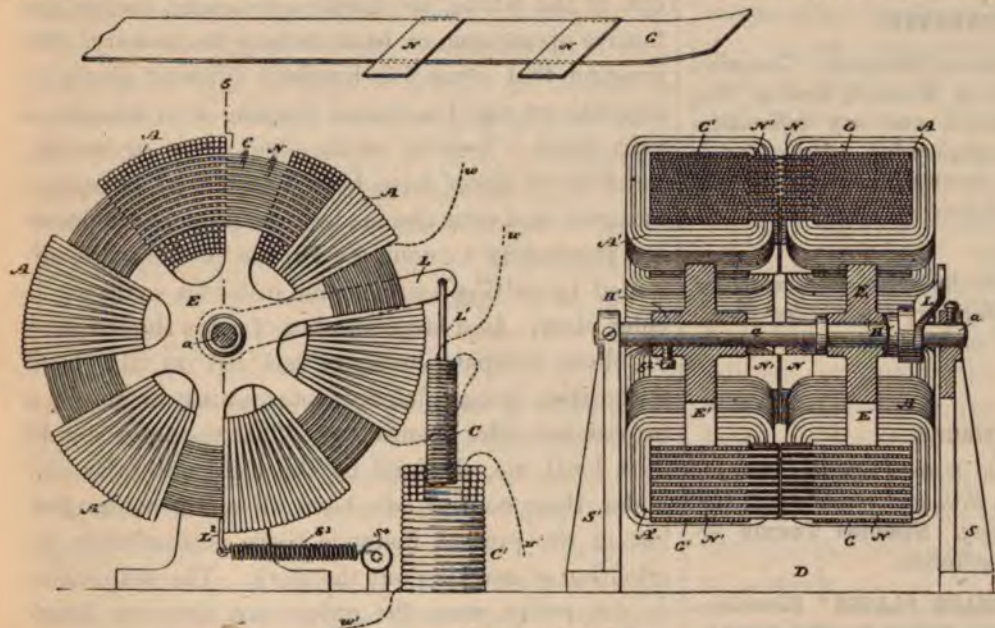
Mounted upon the shaft are two iron spiders, E E', which carry a pair of converter coils, A A', the former, A, constituting a set of primary coils wound in series about the laminated cores, G, and made of long, thin strips of iron having projecting teeth, N N', which constitute the poles of the respective coils, and between which teeth are wound in series on each core the coils A A'. The arrangement is such that when the coils are wound in position the projecting teeth N N' fill the space between the coils on one side and N' N' between those on the other side. The secondary coils, A' A', are

rigidly fixed upon the axis, *a*, by a set screw, which passes through the hub, H, while the primary coils, A A, are free to rotate upon the axis, *a*, and have a lever, L, connected to the hub, H, for producing the rotation. This lever, L, has connected to its free end a solenoid, C, located directly in the primary circuit and in series with the coils A, as shown in Figs. 2 and 3. An additional solenoid, C', is located in the secondary circuit and surrounds the first-named solenoid. The spiral spring, *s*³, attached by the lever L² to the rotary primary coils, and by an adjusting screw, *s*⁴, to a fixed standard, is designed to regulate the relative location of the cores, N N', of the movable and fixed coils under varying conditions.

With this construction the operation of the converter will become evident. Suppose, for instance, that the adjusting screw, *s*⁴, is so adjusted that the spring, *s*³, will hold the coils, A, in the least effective position when a minimum number of lamps are located in the secondary circuit, *w' w'*; then, as the lamps are connected in circuit in the usual manner, the influence of the cores, N N', upon each other, together with the additional influence of the solenoids, C and C', upon each other in their respective circuits, will cause the coils, A, to be rotated in the direction of the arrow shown in Fig. 4. This rotation will continue in succession as lamps are cut into the circuit until a maximum number is reached for the adjustment of the spring, *s*³, at which time the poles, N N', will lie directly opposite to each other, as shown in Fig. 4, and the multiple magnetic circuits through the twelve adjacent poles of the primary and secondary coils will assume a position of maximum efficiency, the regulation for intermediate positions, as required by varying numbers of lamps in the secondary circuit, being at once obvious, the magnetic circuits varying in accordance with the regulation indicated.

Dr. Paget finds it advantageous to build up the two sets of coils of thin iron strips, G G', having magnetic poles, N N', located at definite intervals in each set, and the strip rolled out is shown in Fig. 1.

With the construction and principle explained above it is claimed that the efficiency of the transformer is uniformly high for all loads.—*Electrical World* (New York).



FIGS. 1, 2, and 3.

working at its highest rate—it has been shown that at lower rates of working, and when the converters are not operating at their fullest capacity, the efficiency is not so high. This is obvious from the fact that if a given amount of electrical energy is required to magnetise and demagnetise the primary core on account of its magnetic capacity under all conditions, whether with or without a load in the secondary, then, when there is a minimum number of lamps in use in

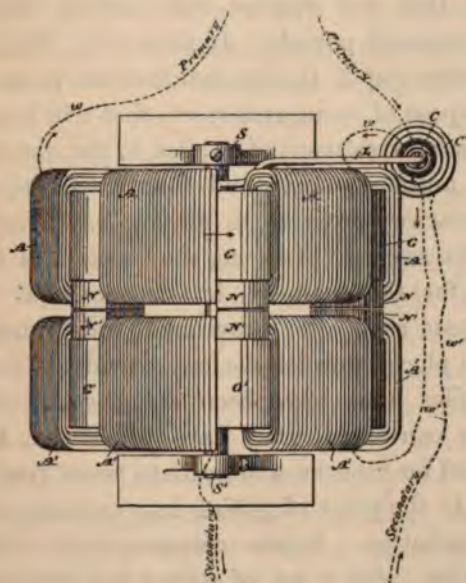


FIG. 4.

the secondary circuit, there will necessarily be much less expenditure of energy in the primary circuit. In order to overcome this difficulty of unequal efficiencies at different loads, Dr. Leonard Paget, of this city, has recently designed a type of transformer which adapts itself to conditions existing in the secondary circuit; that is to say, a transformer which causes the amount of energy utilised in the primary circuit to bear a fixed proportion to the amount

THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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IMPORTANT NOTICE.

We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No paper that we know ever refuses Subscribers or Advertisers. Nor do we; in fact, we invite them, believing that they will get full value for their money.

Specimen copies of the paper will be sent on request.

FALSE OR TRUE.

It has been chronicled that nearly five hundred applications have been made to the Board of Trade, or rather, that number of notices have been given in relation to provisional orders. The officials at the Board of Trade have an invidious task if they really perform their duty, and pitch, without further ado, some four hundred of these notices into the waste-paper basket. We reckon that about that number out of the whole, are merely promoters' tactics, defensive operations, or baits to trap the unwary. To imagine that some five hundred different places or districts are ripe for electric lighting is to imagine a vain thing. Nothing of the kind; ripe or unripe, numbers of places have been invaded by company-mongers, and from the modest two up to half-a-dozen are pretending to compete for the profits to be obtained by getting a provisional order for some particular place. In a large number of cases the invasion of these company-mongers has led to the local authorities in self-defence determining to obtain a provisional order themselves. That the order should be a local one, obtained by the local authority and under their control, we have all along contended, but in the present instance there is absolutely no intention of carrying out the work. The authorities do not really want the orders, but they are determined to keep out the army of promoters who want to feather their nests, without risk, without doing work, and at the expense of a more or less gullible British public. The promises made to obtain support are founded on fictions that those who receive will only understand when it is too late.

There will not be one central station worthy of the name that can require less capital than a hundred thousand pounds. If then only fifty provisional orders out of the five hundred are promoted for the purpose of doing real work, that will involve an immediate investment of capital to the extent of some five million pounds, and that would be perfectly satisfactory progress to all who have thought much on the subject. Leaving the question of *bona fide* work for the moment, let us see what this indiscriminate rush after provisional orders means. In the first place, consider the few individuals, firms, or companies that have been doing good work. They have canvassed, they have influenced, they have worked for months and perhaps years, nursing a place up to the point of getting into working order a small installation. A new company with a high sounding title, with a lot of guinea-pig directors, whose sole object is to advance themselves and their own particular clique at the expense of anybody who can by hook or by crook be brought under the glamour of their statements, these companies and these men, having never "sweated a hair" in this particular town or district, calmly give notice to obtain a provisional order. Both the local autho-

rities, and the men in possession, have to oppose at considerable expense this attempt to reap where they have not sown. Now what do these poachers mean to do? If they get a provisional order, they mean to try and float a company, and get a good big sum for such promotion, leaving those who invest to carry out the work or wind up as the case may be. If the former, the work is carried out with such a load on its shoulders as to prevent its being a paying concern for years—if ever. Wherever and whenever there is a *bona fide* invitation to a company or a firm to exploit a town or district in which no other firm or company is in possession, our remarks do not apply. That is legitimate business. It is not legitimate business to go in for a lot of orders upon the off-chance that a certain percentage of them will be granted, and from those granted to make considerable pickings. The money that will be wasted in promoting impossible orders, and in objecting to them—money that goes to promoters and lawyers, serving no useful purpose whatever so far as the industry is concerned—would, we fancy, be sufficient to start two or three stations very comfortably. Remember the whole of this wasted money comes from the pockets of the public who have been inveigled into contributing to the funds at the disposal of these wirepullers. The men who take the plums are behind the scenes, and take good care to lose nothing themselves. Everything they get is plunder, and when the final crash comes they are found to possess no shares. The misfortune is that there exist side by side with these rotten concerns, stable companies whose directorates and managers are men of the highest honour, whose aim is to do honest work, who will not countenance in any shape or form underhand or doubtful dealings, and these when anything goes wrong are troubled because of sins they have never committed.

To epitomise what we are driving at—firstly, we maintain that the proper people to have the control of local lighting are the local authorities. Any pretentious companies centralised in London or elsewhere, that act as if they were desirous of lighting half the kingdom, are simply in the hands of company-mongers, never have and never can do good work: their sole object is money speculatively obtained. The model to be followed by electric lighting companies is worked out clearly by what has taken place in gas lighting—local men, local companies for local work. Further, these pestiferous promoters are not wanted for the enlightenment of the public. They do harm, not good. Their statements are fiction, not fact. They have their own ends to gain, not the public welfare, and they really know little of what they talk learnedly about. It is the indiscriminate action we are so strongly condemning, not the invited action. We admit a company may initiate local action, may promote local action, and

be justified in every step taken, but then it does not go outside its means. Why, if some of the applicants were allowed all they ask for, or a half even, they could not raise enough money to pay the tax at Somerset House! Lastly, we have strong and grave objections to a foreign fishing company poaching upon the district that someone else has laboriously worked into a fit state of mind to take the electric light. The fishing company may succeed, as such moves often in this world do succeed, but they are not to be commended. The Board of Trade has its work cut out. If it does it well, it will have the thanks of every right-minded member of the community; if it does it badly, we may expect another electric boom, with subsequent disaster and permanent damage. Rushing will benefit us nothing. Fifty millions cannot be profitably expended at present. There are not many Ferrantis about, and few besides Ferranti, and those directly associated with him, really know what a central station for the whole lighting of a town means. Money invested in little petty attempts to put a light here and a light there is not what we want. "All or none" should be the motto of every provisional order, and "all" means more than most folks think.

SILVERTOWN.

The strike seems like the brook—to be likely to go on for ever. We hoped from week to week to have been able to chronicle the termination of the dispute, but it seems to us that this is rendered almost impossible by the action of some of the political papers and partisans. It may be worth while to point out to these people the harm they are doing. Silvertown has another factory in France. The probability is that the management, if they cannot come to terms with their workmen here, will quietly transfer a lot of their work to the French factory. How will this help the labourer, who persists in demanding a higher rate of wage in this case than is paid by competing firms? If this is not killing the goose that lays the golden eggs, we don't know what the process is. In the long run, the labourer will find that employment can be given only to a trifling number compared with the number employed heretofore. It is a misfortune that a man's truest friends often have to give him unpalatable advice; and, considering ourselves true friends of the Silvertown workmen and workwomen, we advise them to make terms with the masters as quickly as possible, or they will find it too late. No end of opprobrious epithets have been showered upon the heads of the management of Silvertown, and upon the heads of prominent shareholders, but we are ready to contend that in no respect, when compared with similar establishments, have the workmen any reason to find

fault. The absurdity of arguing upon an ideal relationship between master and man is clear to everyone who has not an object to serve, and this ideal relationship can only exist when the millennium has converted human dross into human gold. Given men, as men are to be found every day, each working for his own hand, the result must be a kind of trimming all round. The smaller the friction the better for all parties, and in all cases someone must give way. It seems to us in this particular case, where the masters have a second string to their bow, and at the same time have always fully conformed to the ordinary payment of wages in the trade, that the demands of the men are impossible. Why should they alone be asked to increase their wages sheet while others who sell similar goods are not so asked? Is it that someone pulling the hidden strings is desirous of damaging this company in favour of its competitors?

CORRESPONDENCE.

LEAMINGTON TOWN CLERK'S REPORT.

TO THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—We presume it is hardly necessary to point out to the readers of a technical paper like yours the fact that the town clerk of Leamington was mistaken in his statement that the "inseparable objection" to the Thomson-Houston system is that the lights will not burn more than eight hours at a time without renewal, and that to make it a success it would be necessary to have a second set of lamps to turn on when the first set had burnt out.

This, of course, all the world knows is not a fact, and we merely wish to put on record our protest against the appearance of such a statement.—Yours, etc.,

LAING, WHARTON, AND DOWN.

London, W., Nov. 26, 1889.

DERBY CEILING ROSE.

We illustrate herewith a new ceiling rose, manufactured by Messrs. J. Davis and Sons, All Saints' Works, Derby, and named by them the "Derby" ceiling rose. In this A is the usual porcelain ceiling plate or base, and B a porcelain



cap or cover. C C are brass studs fixed to the cover (only one stud being shown); these fit into brass springs, E E, fixed to the base, which hold up the cover, and form the contacts. A fuse, D, with lin. break, is attached to the cover. The complete pendant, including fuse, is self-contained, and is fixed or detached by a turn of the hand, the weight of pendant tending to improve the contact. The cap, with appendage, can be removed at will for cleaning or during the summer. The base can remain in position without harm.

NEW YORK NOTES.

(FROM OUR SPECIAL CORRESPONDENT.)

The Electric Light Situation.
The World's Fair Project.
Government Telegraph Rates.
The Western Union Shows Fight.
The Postmasters in Conference.
A State Electric Lighting Association.
Manufacture of Test Instruments in America.
A New Bridge and Resistance Coils.
The Storage Battery Situation.

NEW YORK, November 16, 1889.

The electric light is gradually making its reappearance in the streets of New York. The companies have apparently resolved to profit by the lesson they received a short time ago, when the newspapers did their level best to throw the public into a state of panic, and are still busy renewing their overhead circuits with good wire and taking down the old material which had remained in service too long. Most of the electric lights in the principal parts of the city are blazing away again, but there is still a fair sprinkling of dark spots, and gangs of workmen are busy every day in many places putting up new conductors. The reign of common-sense seems to have returned, and everybody welcomes the reappearance of the light, which was sadly missed during the past few weeks of darkness that fell upon New York immediately after the death of Feeks. The episode of the horse, which I described last week, fell remarkably flat in spite of the determined efforts of the newspaper men to work it up into a sensational story. It happened the day before election day, and the public mind was too much occupied with political matters to pay much attention to the vagaries of the "deadly wires." Besides the chief sufferer, apart from the horse, was a policeman, and the New York police indulge in so much indiscriminate clubbing and revolver practice without just cause, that no doubt newspaper readers were glad to see the tables turned for once, especially as retaliation was out of the question.

The World's Fair project is now "booming." The committee have decided to withdraw their proposal to use part of Central Park for the site of the Fair, and the opposition to the whole scheme which the proposed use of the park aroused has disappeared. A guarantee fund of five million dollars is being collected by public subscription, and the amount pledged already exceeds three millions. Mr. Edison has subscribed 5,000dols., and the names of various important electrical companies also appear in the list opposite respectable sums. If the exhibition scheme should reach a successful issue, and New York the location chosen, the electrical industries will undoubtedly make a magnificent display.

Dr. Norvin Green, the president of the Western Union Telegraph Company, has addressed another long letter to the Postmaster-General protesting against the new rates for Government telegrams. Dr. Green points out that if the entire business of the company had been done last year at the rates proposed by Mr. Wanamaker, the receipts would have been 4,000,000dols. less than the actual cost of transacting that business. Dr. Green says that the suggestion of a board of arbitration is what his company has always proffered. It has always been willing to give the postal authorities the fullest opportunity to search into the cost of telegraphic business and to accept freely their impartial judgment. If the Postmaster-General prefers to delegate that judgment to a board composed according to his suggestion (which I communicated last week), leaving the rates for this year to be governed by that result, the company will be glad to assent. Mr. Wanamaker, by the way, suggested that the board of arbitration should make recommendations for the rates for the next fiscal year as he considered those for the present one as already fixed. The Western Union Company, however, inclines to view the matter in a different light, as the following resolution, adopted at a meeting recently held, goes to show: "Resolved that this company will transmit as heretofore, with due priority and diligence, all telegrams between the several departments of the Government and their officers and agents; but this company will not accept as final payment the rates established until its rights in that

regard have received such further consideration as it may be able to secure, and the president of this company is hereby directed to file a copy of this, our protest, with the heads of the several executive departments of the United States."

Last week, the Postmaster-General held a conference with the postmasters of some of the larger cities, and he notified them that he will recommend in his report some sort of postal telegraphs in connection with the Post Office Department. Mr. Wanamaker is of opinion that the time for such a movement has come and he will urge it strongly, leaving the details to Congress. Nothing transpired as to what sort of postal telegraphs Mr. Wanamaker wants, whether he means merely the collection and delivery of telegrams by postmen as previously proposed, or whether he intends to go in for the whole business—lock, stock, and barrel. Nor was it clear what advice or assistance the local postmasters could offer with regard to the organisation of a telegraph system, as they could scarcely be expected to know any more about the matter than Mr. Wanamaker himself, and the amount of his knowledge of telegraph matters is apparently very small. That lofty manner, too, of "leaving the details to Congress" is certainly rather unfair to "Congress," and perhaps Congress will prefer to leave the details to Mr. Wanamaker.

Last week the Massachusetts Electric Lighting Association was formed in Boston. About 40 companies were represented at the meeting. The membership of the association is limited to general station companies doing an electric lighting and motor business for commercial purposes. Gas companies doing an electric lighting and motor business may become members, and a number of such companies were represented at the meeting. The objects of the association are "to foster and promote the common interests of its members." A movement is on foot to organise State electrical associations in all States. The promoters of this movement say: "Had there been a properly-organised electrical association in the State of New York to look after proposed legislation, the laws requiring criminals to be executed by electricity, and creating a 'Board of Electrical Control' in New York City, composed exclusively of politicians (there being no electrician in its membership), would never have made New York the electrical plague spot of the country. The damage done to the electrical industry by these two laws is simply enormous. Such damage may be perpetuated if effective measures of prevention are not provided."

Until comparatively lately American manufacturers have not found themselves equal to the production of fine apparatus, such as station measuring instruments and test instruments, the majority of those in use, especially of the latter kind, being of English make. Things are changing, however, and now several well-known firms are devoting themselves to the manufacture of this indispensable class of electrical appliances. The Western Electric Company, which manufactures almost everything electrical, is at present engaged on turning out high-class test and measuring instruments, the new department being under the direction of Mr. George Hamilton, for many years chief electrician to the Western Union Telegraph Company, and who joined the forces of the Western Electric a few months ago.

Messrs. James Queen and Co., of Philadelphia, are also attracting attention in the same line of business, and they have lately brought out a new standard resistance-box and Wheatstone bridge, designed by Prof. W. A. Anthony, which embraces some novel and valuable features. The coils in this set consist of ten $\frac{1}{10}$ ohm, ten units, ten tens, ten hundreds, and ten thousands, giving an aggregate resistance of 11,111 ohms. The terminal blocks of the coils, instead of being arranged as dials, are set out in rows, thus greatly facilitating the cleaning of the ebonite top. By this arrangement of the terminal blocks in rows instead of in circles, it is also possible to connect up the coils in series or in multiple arc at will. In this way a constant check can be kept on the accuracy of the coils as it is always easy to compare them with the standard and also with one another. The arms of the bridge contain one, 10, 100, 1,000, and 10,000 ohms on each side; a fixed double

plug reverser is mounted at the centre of the bridge. An ingenious device for determining the temperature of the coils has lately been added to this set by Prof. Anthony. This consists of a "temperature coil" of copper wire, whose resistance at the standard temperature is 266 ohms, and a change in the apparent resistance of this coil measured by the coils of the set, which are wound with platinoid, is equivalent to a change in the temperature of the coil, and consequently of the whole set, of 1 deg. C.

The storage battery situation remains practically *in statu quo*. The Fourth-avenue cars are still laid up, to the regret of both the travelling public and the electrical fraternity, and the Julien Company are busily engaged on the manufacture of "dry powder" plates, by pressure, which will be used on the cars in question. The Julien Company state that it is a relief to them to know just what the court wants, and that in meeting the terms of the latest decision they promise to produce a battery superior to anything that they have yet obtained from their experiments and practical work. If this should be fulfilled, the injunction will certainly prove to be a blessing in disguise, but it is curious that the Julien Company should have waited for the courts to compel them to improve their processes. There is a rumour afloat of a "combine" between the Julien and Brush storage battery interests, whereby, under the Brush patents controlling broadly the mechanical application of the active material, the Julien Company would be masters of the situation. The Brush patent covers the broad principle of mechanical application to the support plate, no matter in what form; it also covers the invention of receptacles or perforations in the support plate. A decision in the case is awaited with much interest.

SHEFFIELD AND ELECTROPLATING.

High jinks were carried on by the employés and guests of Messrs. Walker and Hall, of the Electro Works, Sheffield, last week, in honour of the coming of age of the eldest son of the senior partner, Lieut.-Colonel J. E. Bingham, J.P., of the firm. The festivities appeal to us inasmuch as Mr. Walker was the first to introduce electroplating as a commercial pursuit into Sheffield.

Mr. Darwin, in proposing continued success to the firm, pointed this out. Among other things, he said, having been connected with Walker and Hall for over 30 years, it had been considered an opportune moment to give a *resumé* of the rise and progress of the firm, who might claim to be almost the originators, and certainly Mr. Walker was the first to introduce practical electroplating as a commercial pursuit in Sheffield. Mr. Walker, the founder of the firm, was engaged to assist the late Mr. Wright, an apprentice of old Dr. Shearman, and who subsequently became the successful inventor of electroplating. Frequently since his retirement from business, Mr. Walker had explained to him the many difficulties he had to encounter during his early business career, for when he began electroplating he had everything to do by himself—all had to be created. Mr. Walker was not only the first successful practical plater, but he was also the actual inventor of that part which had since become perhaps one of the largest branches in the electroplate trade. The process was never patented, it being regarded as so capable of imitation that Mr. Walker was satisfied to keep the thing simply a secret within his own place. The system only leaked out to the world by degrees, and there were still many firms who were obliged to use a coating of copper between the article and the silver. The business was begun in what was known as the "boil shop." Being only a poor man, Mr. Walker felt the necessity of capital and also the lack of commercial knowledge. These were combined in Mr. Hall, the late and most respected uncle of their present proprietors. This excellent gentleman joined Mr. Walker, and the firm had soon to increase their premises by adding those previously occupied by the late Dr. Knight, and it was in this very house that the inventor of electroplating and Mr. Walker first met. There, in addition to plating for all the manufacturers in Sheffield and others, they began to make spoons and forks, and thus they succeeded in establishing a

business which was a credit to themselves and an honour to their memory. In 1856 Mr. Hall introduced his nephew, Mr. John E. Bingham, who was then a young man very similar in appearance and manner to his son, whose majority they were that day celebrating. Mr. Bingham promptly gave evidence of energy and foresight, and when he eventually got the reins into his own hands, one of the first things he did was to persuade his then principals to adopt a corporate mark, one that would secure and more firmly establish the good name for sterling quality which was always, and was to-day, their determination to maintain. That mark was the well-known and universally-distributed flag, attached as it was to articles of their manufacture in every part of the known world, and one that was recognised everywhere as denoting a standard of high quality. In the words of a factory wag—

The flag that's braved a thousand storms
The battle and the breeze,
Is very often to be found
On "Coffees" and on "Tees."

The next step was the production of cutlery in steel, electroplate, and silver, followed by the manufacture of hollow-ware, and, subsequently, a department for the production of plated Britannia metal goods. After supplying the merchants of Sheffield for some time, Mr. Bingham decided to get into direct communication with the London merchants for foreign trade, and to reach the country jewellers and cutlers, in order not only to display their designs, but to maintain their workmanship and prove the quality of their wares by being able to impress their trade mark, the flag, upon their goods. Shortly after Mr. Walker retired, followed at a later period by Mr. Hall, both maintaining to the end a kindly feeling to their old workpeople and successors. Mr. J. E. Bingham, who was for some time sole proprietor with the business under his entire charge, was eventually joined by his brother, Mr. Charles H. Bingham, who, by his industry and mechanical knowledge, had materially contributed to the general success of the business, which had grown from an affair engaging about 20 hands to a huge establishment constantly employing more than 700 workpeople. He had no doubt Walker and Hall were now the largest manufacturers of electroplated and silver goods in England. During that time the relations between masters and servants had been of the most pleasing and harmonious character, largely owing, no doubt, to the fact that almost every member of the managing staff, and many of the workpeople, had been there the whole of their working lives. The firm had always invited them to join in their festivities, the celebration that evening being the largest yet held—over 850 workpeople and wives being present. The first and smallest was held in a hotel in High-street in 1863, when they met to celebrate the marriage of Mr. and Mrs. J. E. Bingham. Some years later they assembled at the Cutlers' Hall to celebrate, not only the marriage of Mr. and Mrs. C. H. Bingham, but also to welcome Mr. Charles as a partner. The senior principal had been elected by the Cutlers' Company as Master Cutler on two separate occasions—an honour for which, he believed, there had been no precedent. Mr. Charles Bingham was rising into position in the company, and before long would no doubt be at its head, when he would no doubt entertain his friends, including, of course, his workpeople in that title. During his second year of office Mr. J. E. Bingham initiated the Sheffield Workmen's Handicrafts Exhibition, which was opened by His Royal Highness Prince Albert Victor, and Mr. Bingham had the honour of introducing the Prince to his workpeople, at the works, and afterwards of entertaining him at a dinner at which several of them were present.

The Chairman (Lieut.-Col. Bingham) in his reply referred to the introduction of this industry, and remarked that he desired there, speaking before that company, to remember those who had borne the burden of the promotion of electroplating in Sheffield—Mr. Walker and Mr. Hall—who after a useful and honoured life had gone to the rest they had so thoroughly earned, and which he hoped they would all, employer and employed alike, succeed in obtaining after the turmoil and trouble of life were past. Their trade mark, as they had been reminded, was the flag, and he

trusted they would take firm grip of the staff of that flag, and rear it steadily, and hold it truly, in the cause of Walker and Hall.

THE EDINBURGH EXHIBITION.

The following communication has been sent to the members interested by the secretary of the London Chamber of Commerce :

Sir,—I beg to send you appended copy of the report of the Special Committee of the section on the Edinburgh Exhibition, together with Mr. Lee Bapty's reply thereto, in accordance with the following resolution passed unanimously at a meeting of the Electrical and Allied Trades' Section Committee, held on Monday, the 25th inst., "That Mr. Lee Bapty's letter be circulated, together with copy of the report of the Special Committee, to each member of the electrical section, and each member be requested, not later than December 5, to inform the secretary of the London Chamber of Commerce, Eastcheap, E.C., for the information of the committee, whether he, or his firm, or company, purpose exhibiting at Edinburgh on these terms." I shall be glad to receive your reply at your earliest convenience.

Report of the Special Committee on the Edinburgh Exhibition

At the meeting of the committee of the section which was held on 28th October, the following resolution was proposed by Major Flood Page, seconded by Mr. Swinburne, and carried unanimously: "That with a view of the electrical industry taking common and united action with regard to the proposed electrical exhibition in Edinburgh in 1890, a committee be appointed to consider the conditions on which it may be advisable to take part in the exhibition, and that a meeting of the electrical section of the Chamber be called for Monday, 11th November, to receive the report, and if thought advisable to take action thereupon."

Your committee have considered the question referred to them in the above resolution and have the honour to report as follows :

1. If the exhibition committee in Edinburgh had consulted the electrical trade as to the desirability of holding an electrical exhibition in the year 1890, they would probably have received a well-nigh unanimous answer that it was too soon after the Paris Exhibition to serve any useful trade purpose.

2. The opinion of the industry on such a matter can easily be ascertained now that an electrical section of the London Chamber of Commerce has been formed, as members from all parts of the kingdom belong to that section.

3. Nevertheless, the exhibition being in course of organisation, it seems advisable that the trade should not refrain from exhibiting, provided that terms could be obtained from the exhibition authorities more favourable to the trade than those provided in the regulations which have been issued.

4. It must be clearly understood that this report is not dealing with the question of lighting the exhibition, for which, of course, the exhibition authorities must pay in the usual manner, nor with any question involving the purchase or hire of any electrical plant which the exhibition authorities may require for their own purposes, and but simply with the question of exhibitors.

5. The charge for space is to be 2s. 6d. per square foot, the minimum charge being £2. 10s. We think that the electrical exhibitors should be allowed an agreed upon space, and should pay for any additional space they may require.

6. Many of the electrical exhibits, though not intended in any way to light the exhibition, cannot be properly shown unless they have steam or current supplied. We think that when steam power or current is necessary for the proper display of the exhibit, they should be provided by the exhibition authorities free of cost to the exhibitors.

7. The regulations provide that the exhibitors should furnish all necessary attendants. We recommend that for electrical exhibits, where there is no machinery in motion, the electrical section should club together and appoint and pay for such attendants as they may judge necessary.

8. We think that the exhibition authorities ought to pay for the insurance of the electrical exhibits.

9. We suggest that there should not be any awards, but if it is determined to have awards we think that the Council of the Institution of Electrical Engineers and the Electrical Section of the London Chamber of Commerce should recommend the jurymen to the exhibition authorities.

10. Clause 25 of the regulations is as follows: "The executive council reserve to themselves the right of examining, testing, or analysing any of the exhibits."

We do not think that any person whatever, except the electrical jury should have the right to test, analyse or examine (in the sense here meant) any of the electrical exhibits, and we think that any electrical exhibit may be sent without being in competition, and such exhibits should not be tested or analysed even by the jury.

11. In conclusion, although the whole of the electrical trade is now busier than it has ever been, and is certain to be busy all through the year 1890, and much valuable time will be occupied in the preparation for the Edinburgh Exhibition, and, although it is not likely that any profit or advantage will accrue to the electrical exhibitors, yet, on the whole, as the Queen has given her support to the exhibition, and Scotland generally seems inclined to do what can be done to make the exhibition a success, we think that the electrical trade should not "boycott" the exhibition, but we strongly urge that the permanent committee of the section should obtain terms at least as favourable as those indicated above.

12. Your committee have good reason to believe that well nigh the entire trade will support such improved and reasonable conditions as we have suggested.—Signed on behalf of the committee, S. FLOOD PAGE.

Reply on behalf of the Edinburgh Exhibition.

To Major S. Flood Page, the Electrical and Allied Trades Section of the London Chamber of Commerce.

Sir,—I have placed before my council the report of your Special Committee on the Edinburgh Exhibition, and am instructed to communicate the decision at which they have arrived as under. The concessions offered are such as have never before been granted, and will, I trust, be found of such a nature that you will be able to recommend them for acceptance by your section.

I need not further enter into the matter of your section, not having been consulted by my council before issuing their prospectus, but would repeat that there was no intentional neglect nor discourtesy meant.

The first point of importance is contained in

Paragraph 5. With regard to payment for space, my council have approved the suggestion I made when attending your committee on Monday week last, and will undertake to return to exhibitors of electrical inventions, apparatus, plant, etc., all moneys which they may pay to the council by way of rent for space, provided the net surplus be sufficiently large to enable them to do so, and in the event of a smaller surplus to refund a *pro rata* amount. I may say that a surplus is practically certain.

Paragraph 6. Motive Power.—My council are prepared to concede to your wishes with regard to steam or belt power, which will be supplied free, and with regard to electric current, the power necessary to generate it will be given, but the dynamos should be provided by some of your exhibiting firms.

Paragraph 7. Attendants.—I note the suggestion of your sub-committee, which is very practical, and I shall be glad to assist in any way I can to reduce exhibitors' expenses in this direction, by allowing the ordinary exhibition attendants to help your technical attendants when extra manual labour is required.

Paragraph 8. Insurance.—This is a matter which my council cannot see their way to undertake. But I am instructed to say that every possible precaution will be taken to prevent a fire; the most efficient apparatus will be provided, stringent regulations will be carried out, an efficient force of firemen and watchmen will be on duty night and day, and the whole staff will be regularly drilled in fire exercises. I may add that at the Royal Jubilee Exhibition, Manchester, where we had about four million pounds' worth of property, not one claim was made, and this I

attribute entirely to efficient watching and proper apparatus, and I intend to introduce exactly the same system here, so that the risk of fire will be reduced to a minimum.

Paragraph 9. Awards.—My council are prepared to practically abide by your suggestion as to awards and the choice of judges, and, in case it should be decided to institute practical tests, will provide the necessary power, but the other costs incidental they think should be borne *pro rata* by the exhibitors competing.

Paragraph 10. Testing, etc.—My council concurs entirely in your views, as expressed in this paragraph.

Paragraph 12. I sincerely trust that, as your wishes have been so fully if not entirely met, the entire trade will now co-operate with us, as foreshadowed in the paragraph, and, with your aid, we shall have the finest electrical exhibition ever held.

In reference to the request of an extension of time for the entries, which is not mentioned in your sub-committee's report, I will bring the matter before the executive council, who will have much pleasure in acceding to your request, only urging that, although the closing date will be altered to January 1, 1890, the applications will be sent in *as soon as possible* to facilitate arrangements.

The lighting will, of course, be provided by contracts, for which specifications will be at once issued.

I think I have now fairly covered the ground of your committee's report, and again reiterating the hope that we may now reckon upon your cordial co-operation.—I have the honour to be, sir, faithfully yours,

S. LEE BAPTIST, General Manager.

NEWCASTLE-ON-TYNE.

We have given a considerable amount of space to the state of things electrical at Newcastle, and to keep up the continuity of history ought to give the following letter, addressed to the mayor by the chairman of one of the companies:

"Newcastle-upon Tyne, November 12, 1889.

"Sir,—I am requested by the directors of the Newcastle and District Electric Lighting Company, Limited, to communicate with your worship as to the delay which has occurred in connection with the grant of the license from the Board of Trade to the company, and I would beg to draw your serious attention to the following circumstances.

"The Electric Lighting Act of 1882 provides that the consent of a local authority shall be required to the application for a license to supply electricity within the jurisdiction of the authority, and that the applicants shall publish notice of their application by advertisements in the local papers. The license is not to be granted until after the expiration of three months from the first publication, nor until opportunity has been given to all parties interested to make representations or objections to the Board of Trade with reference to the application. At the expiration of the statutory period it is clearly the spirit and intention of the Act that the license should be granted either immediately or, at all events, within a reasonable time.

"The consent of the Corporation to the application by my company for a license was given on the 6th March last, and the statutory period of three months for sending in objections expired on the 28th May last. No objections to the application were received from any quarter.

"Immediate progress was made with the preparation of the license, the draft of which was at once submitted to the Board of Trade for their approval. They made various alterations in the draft, which were from time to time submitted to the Corporation, and ultimately, on September 4 last, a resolution was passed by the Council approving the license in its then form.

"My company fully expected that, all matters having thus been arranged between the Corporation and themselves, the license would be at once granted. They were, however, informed by the Board of Trade that an objection of a highly technical nature had been made on the part of the Corporation to the effect that there is no existing power to recover in a Court of Summary Jurisdiction the penalties

specified in the license for offences which may be committed against the provisions of the license. My company have used their best endeavours to dispose of this objection, but they are now informed by the Board of Trade that the granting of the license will probably be indefinitely postponed, as it is likely that special legislation will be required in the ensuing session of Parliament to deal with the point which has been raised.

"My company have expended a large capital in making and completing the necessary arrangements for the supply of electricity, and they have for some time past been in a position to supply it whenever the necessary permission to commence operations could be obtained. They have already secured a large number of customers, who have signed agreements with them for a supply to nearly 6,000 lamps, and they would be prepared to supply electricity within a very few days of permission being granted to lay down their mains in the streets of Newcastle.

"The delay which has occurred, and is likely to occur if no remedy can be found for the present position of matters, is likely to prove disastrous to the company, and injurious to the public interest. The large capital expended by the company has for some time been lying unproductive, and the public are deprived of the benefit which they will receive from the supply of the electric light. Many of the large commercial and other institutions of the town have arranged with my company for the supply, to them, of the electric light, and some of them have expended considerable sums in preparing the necessary fittings for their premises.

"Under the above circumstances the directors feel that they have a strong claim upon the Corporation to assist them, so far as this can be done without injury to the public interests. They believe that the Corporation and the company are agreed upon all points connected with the license, and that no difference of any kind is likely to arise in the future between the Corporation and themselves. They are most anxious to comply with all the regulations of the Corporation, and in order to meet the objection which has been raised they are willing to deposit with the Corporation a suitable sum of money, and to enter into an agreement that this sum shall, from time to time, be applied in or towards payment of any penalties that may be incurred, or of any expenses in which the Corporation may be involved by possible default on the part of the company.

"The directors have therefore requested me to bring these facts under the notice of your worship, and to respectfully urge that you will be good enough to lay them before the City Council at their next meeting with the object of permission being granted to my company to lay down their mains in the streets without further delay. The company will be prepared in so doing to conform with any reasonable regulations which the city engineer may think it necessary to impose, and the directors will be glad to wait upon your worship or the City Council to give any further information or explanations which may be required.—I am, sir, yours obediently (for the Newcastle and District Electric Lighting Company, Limited),

"JOHN D. MILBURN, Chairman of Directors."

SOLDERING FLUX.

Mr. J. H. Watkins, of Eccles, sends us a sample of a new soldering flux, together with a cable-joint soldered by using the flux.

"Ordinary powdered rosin has," he says, "up to the present time, been regarded as the best flux to use whenever possible, as it does not corrode metals as spirits of salts and other soldering fluids do, but its inconvenience and unsuitability often causes workmen to shirk its use, being difficult to handle, and requiring considerable skill and time to make a good job with it. Recognising the fact that rosin must form the base of the soldering fluid of the future, I succeeded, after a considerable number of experiments, in obtaining an entirely neutral solvent, which would not have any corroding effects whatever on metals, and which could be easily vapourised by the application of heat, and leave a coating of pure rosin on each part of the joint to which the flux

was applied. The outcome of these experiments was the production of the resinous soldering flux, which fulfils all the requirements of a perfect soldering flux. Being a limpid liquid it easily permeates a joint, and on the application of heat the solvent is vapourised and a coating of pure rosin deposited. The flux, although it has a slight cleansing action on metals, is entirely non-corrosive and causes the solder to run very freely."

We have had no opportunity of trying this flux, as it arrived only a short time before going to press, but if it is as good as its inventor says, it certainly will be useful to the profession. The joint sent is, of course, well done, but it requires more than a visual examination to say whether it is really as good as it looks. After a trial, we may have something more to say on the subject.

THE LIGHTING OF THE CENTENNIAL INTERNATIONAL EXHIBITION, MELBOURNE, 1888 AND 1889.*

BY K. L. MURRAY, C.E., TELEGRAPH ENGINEER TO THE VICTORIAN RAILWAYS, MEMBER.

(Concluded from page 416.)

As there is no direct method of ascertaining the power absorbed by Foucault currents and magnetic viscosity while the machines are at work (the usual method being to find the value of all directly measureable quantities and subtract their sum from the total power absorbed by the machine, the balance being debited to the above causes), an attempt was made to find approximately the alteration in the magnitude of these losses corresponding with given variations in the total induction through the armature, by the following method:

The dynamometer pulley was placed on the machine to be tested, the field-magnets were arranged so that they could be separately excited by a variable current, and the commutator brushes were removed from the machine. The zero of the pulley was noted, and the machine then run at the normal speed, the deflection produced on the pulley indicating the power absorbed by mechanical friction. The field-magnets were then gradually excited and simultaneous deflections on the ampere-meter and pulley noted, the speed of rotation of the armature being also taken. From the data thus obtained the curves on the diagram (Fig. 2) were drawn.

It must not be forgotten that the value obtained for the waste power, corresponding with a given degree of field excitation, does not necessarily represent that which actually takes place when the machine is at work with the given degree of field excitation. The modifying influence of the current in the armature cannot well be estimated. The reduction produced by it in the total induction through the armature core would tend to lessen these losses. At the same time the losses in both armature core and pole-pieces would be increased, owing to the forward rotation of the field by the armature current crowding up, as it were, the lines of force into a smaller space, so increasing the E.M.F.

of the induced currents, the value of which is always $\frac{dn}{dt}$.

Another source of difficulty in the Brush machine is the uncertainty of the effect produced by the great oscillation of the armature field (about 40deg.), owing to the small number of commutator segments. The curves shown on diagram II. present some striking peculiarities.

The points from which the several curves start on the vertical line for $C=0$ may be regarded as their respective origins. The power indicated by the portion of the ordinates below this point is due to mechanical friction, and is constant for all degrees of excitation of the field. The curves Nos. 462A and B were taken with the machine cold and hot respectively. It will be observed that less power is wastefully absorbed when the machine is hot than when cold, and that as the two curves start from the same point the difference is not due to mechanical causes. These curves show in the early part a very slow rise in the waste power for a given increment in the field exci-

* Paper read before the Institution of Electrical Engineers on Thursday, November 14.

tation ; but as the excitation is increased the lost power rises with an increasing rate. On the same diagram the curves marked Nos. 1,856A and B were taken with increasing and decreasing currents in the field-coils respectively. By reference to table C it will be seen that dynamo No. 1,856 is one of those in which the efficiency rises and falls with the current in the circuit. The curve taken with an increasing current is the only one of interest. The early portion is peculiar, and I can see no satisfactory explanation of the peculiarity. From the point where the

The curves given in diagram II. express the horse-power absorbed in driving the armature (on open circuit) through the variable magnetic field as a function of the exciting current. This method of representation is purely arbitrary, though convenient when it is simply desired to ascertain the alteration in the power absorbed for a given change in the exciting current.

The power required to drive the armature on open circuit through a magnetic field clearly will not depend on the value of the exciting current, but on the number of lines of

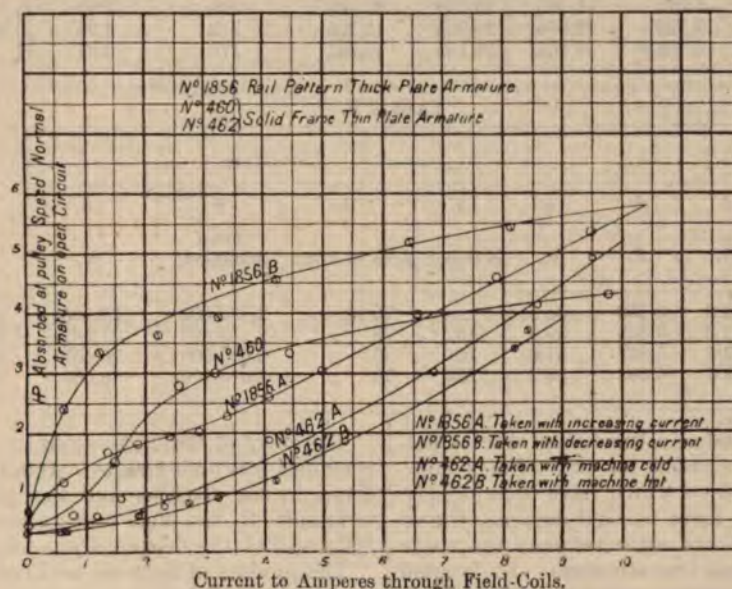


FIG. 2.

exciting current is four amperes the curve is nearly a straight line, which, if produced downwards, would pass through the origin. In this machine, then, the power absorbed, driving the armature (on open circuit) through the magnetic field increases directly as the current at least

force which the given excitation can force through the magnetic circuit of the machine. Those lines of force only which pass through the armature produce any useful effect. Consequently, if it is desired to ascertain the rate at which the lost power increases with the useful induction, the

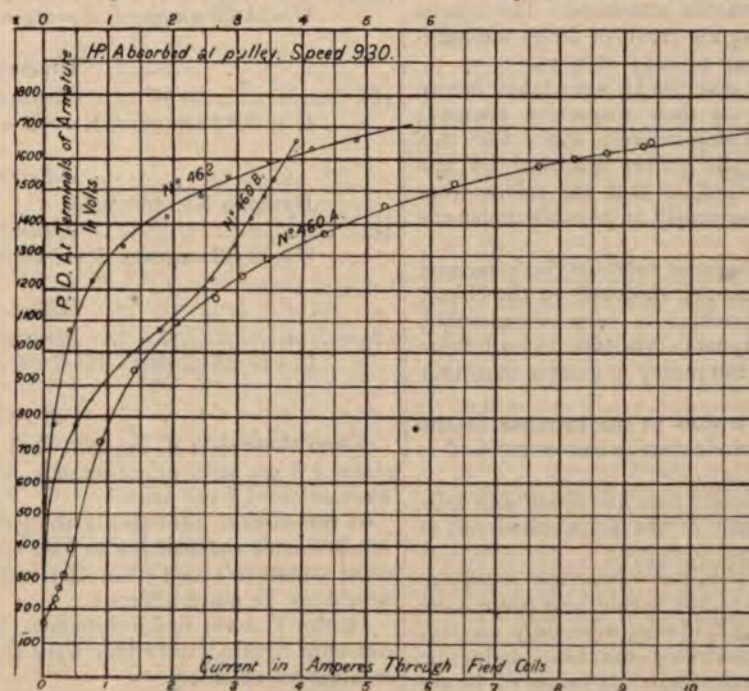


FIG. 3.

between the values $C = 4$ and $C = 10$. But the power required to overcome mechanical friction is constant. Hence, if the resistance of the circuit remains constant, as it practically does in this case, the efficiency of the machine will rise and fall with the current taken from it. Curve No. 460 was taken from the other machine, in which the efficiency and current rise and fall together. The power absorbed by the armature on open circuit increases at first very rapidly with the current ; but when the current has reached three amperes the rate of increase is not so great, and it ultimately tends towards a small constant rate of increase.

curves given in diagram II. should be expressed as a function of the total induction through the armature.

The curves in diagram I. may be taken as curves of induction through the armature, expressed as a function of the exciting current.

The curve of induction through the armature of dynamo No. 460, is shown in the diagram (Fig. 3), and is marked No. 460A. The ordinates of curve No. 460B represent the power required to drive the armature (on open circuit) where the induction through it is proportional to the abscissa.

A similar curve from dynamo No. 462, in which the

TABLE D.—DISTRIBUTION OF ENERGY SUPPLIED TO ARC DYNAMOS (No. 7L).

Maker's number.	Expressed in watts.								Remarks.
	Accounted for.					6 Absorbed at pulley.	Not accounted for.		
	1	2	3	4	5		7	8	
	Mechanical friction.	C ² R.	False induction, etc.	Available at terminals.	Total.		6 - 5	Per cent. of total, 6.	
1,856	338.2	1,376.8	4,011	14,703	19,799	20,108	309	1.53	Machine cold.
460	458	1,029.2	2,720	12,046	16,253	16,765	512	3.05	
462	230	1,223	3,798.4	12,902	18,153	18,331	178	0.97	

TABLE E.

Machine.						Armature.				Remarks.
1 Maker's number.	2 Area of F.M. core.	3 Ampere turns, F.M.	4 H.	5 B.	6 μ .	7 Number.	8 Area of core.	9 Total induction.	10 B.	
1,844	442	43,200	122.8	4,882	36.5	...	78 sq. cm.	2,158,000	27,666	Solid frame } Solid frame } Machine cold. Rail pattern } Rail pattern }
460	442	43,200	122.8	4,825	39.3	157	78 "	2,132,600	27,341	
1,849	442	43,200	122.8	4,647	37.8	161	78 "	2,054,000	26,333	
1,840	442	43,200	122.8	4,692	38.2	152	78 "	2,073,700	26,586	

power wasted is also expressed as a function of the induction through the armature, is added for the sake of comparison. The same peculiarities which have been already noticed are now shown in a more marked degree. Curve 460B tends towards a constant ratio between the waste power and induction through the armature. In dynamo No. 462 the waste power increases enormously, with high values of induction through the armature.

The distribution of energy supplied to three of the machines is tabulated on table D.

The figures given in column 3 are taken from the ordinates corresponding to the given current on diagram II. They do not necessarily represent the true value of the loss when a current is taken from the armature. The figures given in the other columns are the result of direct measurements while the machines were actually at work.

The data for the curves in diagram II. were taken before the machines were started on their respective circuits; they would, therefore, be comparatively cool. For this reason the distribution of the power absorbed by the machines when cold was selected, so that the values from diagram II. would be taken as nearly as possible under the same conditions.

It will be seen that the difference between the measured total and the sum of the energy absorbed in the circuit and various parts of the machine is very considerable, especially so in the case of dynamo No. 460. In all three cases the power absorbed at the pulley is greater than that which can be accounted for.

Probably this difference is due to an increase in the power absorbed by useless induction when a current is taken from the armature.

In table E a few approximate data are given with reference to the general condition of the magnetic circuit of these machines.

The values given were obtained with the armature running at the normal speed of 930 revolutions per minute on open circuit, the field-magnets being separately excited. In columns 9 and 10 respectively the total induction through the armatures, and corresponding values of B, are given. These and the dimensions constitute the only useful data. In columns 5 and 6 the corresponding values of B and μ for the field cores are given, assuming no leakage to exist. This, of course, is not the case. The figures simply indicate a low useful value of B in the field cores.

When the machines are generating a current all the values given will be altered. The actual value of B for the armature of dynamo No. 460 would be 23,028 when the machine is giving a mean current of 10.1 amperes.*

* Armature E. M. F. = terminal P. D. + C R + back E. M. F. in field coils.
= 1,220 + 126.25 + 57.2;
Total = 1,403.45 volts.

The effect of the fluctuations in the current given by the machines was observed by carefully measuring the current given by the machine and the potential difference at the terminals of the field-coils; immediately afterwards the resistance of the field-coils was taken.

The product of the measured resistance and current gives the potential difference requisite to maintain a steady current of the given value through the field-coils. Subtracting this quantity from the potential difference actually measured, the remainder represents the mean E. M. F. due to self-induction.

Dynamo No. 460, hot.

(1) Measured P. D. = 144.04 volts.
C = 11.09 amperes, R = 8.2 ω . C R = 91.00 "

Difference 53 "

(2) Measured P. D. = 139.0 "

C = 9.82 amperes, R = 8.2 ω . C R = 80.5 "

Difference 58.5 "

Dynamo No. 460, cold.

(1) Measured P. D. = 140.5 volts.
C = 11.33 amperes, R = 7.06 ω . C R = 80.0 "

Difference 60.5 "

(2) Measured P. D. = 138.27 "

C = 10.85 amperes, R = 7.06 ω . C R = 76.6 "

Difference 61.67 "

From these data it appears that the current fluctuates about 1.5 per cent. on either side of the mean, or a total fluctuation of 3 per cent.

If the current were steady the gain in the field-coils only would enable the machine to feed one extra lamp with the same armature speed; but the efficiency of the machine would not be much affected.

Of the Victoria Brush dynamos (No. E2 used for incandescence lighting) only four were tested to ascertain their commercial efficiency.

Much more complete details of the behaviour of this class of machine are given in the various journals than can be found of the Brush arc dynamo. For this reason it was not considered worth while to multiply tests of the Victoria Brush machines.

VICTORIA DYNAMOS, HOT.

No. of machine	Current in amperes.	P. D. at terminals, in volts.	E C 746	H. P. absorbed at pulley.	Commercial efficiency.
1823	192.96	108.49	26.06	36.28	77.34
1822	236.66	106.85	33.89	41.82	81.03
1587	90.013	97.66	11.78	17.71	66.52
1825	246.2	110.6	36.5	42.33	66.2

The method of testing was exactly similar to that used for the arc machines, excepting that both pistons in the dynamometer pulley were used, whereas in testing the arc machines only one piston was required.

The very small current taken from dynamo No. 1,587 will account for the low efficiency shown, as the losses are almost independent of the output. As a whole, the efficiency of these machines is less than was expected.

To conclude. More complete tests, to ascertain the magnitude of the various losses which take place in the machines; the values of H , B , and μ , for both fields and armatures; the exact magnitude and form of the fluctuations in the current from the arc machines, and its effect in lessening the output from the machines are much to be desired.

It would also have been instructive to have made a long series of tests obtaining data from which curves similar to those given in diagrams II. and III. might be drawn, so ascertaining practically the law in accordance with which the power uselessly absorbed varies.

The very considerable differences in the efficiency of the various dynamos, working as nearly as possible under the same external conditions, and having to all appearance similar armatures, is apparent, and the question is, To what are these differences due?

It would seem that they must be caused by differences in construction, by which the deleterious reactions in the machines are altered; but if the tests which I have recorded in this paper could have been extended, and made under various conditions, some light would probably have been thrown on the point. The close agreement of the curves in diagram I., and the great dissimilarity of those in diagram II., seem to indicate differences in the quality or arrangement of the iron forming the armature cores.

There were no spare machines at the exhibition, the whole number obtainable being in constant use; hence the tests made had to be confined to the shortest possible time, so that the lighting of the building should not be interfered with. This is the reason why further tests were not made, and also for the meagre and somewhat unsatisfactory nature of many of the data given.

Such as it is, however, I submit this paper to the members of the Institution of Electrical Engineers with the hope that there may be something in it which will draw forth remarks from some of them whose great experience makes anything they say valuable.

At the Spencer-street railway station, Melbourne, I have had for some years a small installation of about 60 Brush arc lamps at work lighting the station yard, and I am now arranging for a central lighting station, from which about 800 arc and 4,000 to 5,000 incandescent lamps will be lighted. Thirty of the Brush arc dynamos used at the exhibition have been purchased and will be utilised, most of them being fitted with new armatures, which I will have made upon lines that I hope, and believe, will prove satisfactory. At any rate, I will avoid the evident errors in construction of the armatures sent out from England with these machines.

If considered of sufficient interest, I will be glad at some future time to give the result of the work done, and also the details of some experiments made with a view to test the propriety of laminating the field-magnet cores as well as the armatures.

ABSTRACT OF DISCUSSION.

Mr. Mordey said the author was to be congratulated on the great care with which the investigations described in the paper had been carried out, particularly as no such tests had been previously made outside the manufactories. He thought, however, that Mr. Murray had given undue weight to the mechanical defects of the "thin-plate" Brush armatures, for these defects were discovered at the Brush works before the opening of the exhibition, and immediately remedied. Again, great stress was laid on the alleged fluctuations of the current from Brush dynamos. Some years ago, when Profs. Ayrton and Perry described their "discontinuity meter" before the society, the speaker made tests on the currents in Brush arc circuits, but no discontinuity was perceived. More recently similar experiments had been made by passing the current through transformers, but no secondary E.M.F. could be detected. Referring to the effects of fluctuations described on slip 15 of the proof, he could not see how the 3 per cent. variation was deduced from the numbers given, and, as a possible explanation of the observed difference between the potential difference and the product, $C R$, the speaker pointed out that if a perfectly steady current passed through the armature, the Pacinotti projections would induce

currents in the field-coils. The comparatively low efficiencies of the Brush Victoria machines were probably owing to their being worked below their normal output.

Prof. Ayrton said he thought Mr. Mordey's inability to obtain evidence of discontinuity might arise from his using coils with iron cores and closed magnetic circuits, for in such apparatus very little effect is produced by small changes in the magnetising current. There was no doubt whatever that a great difference existed in the constancy of the currents from the Brush and Gramme machines used with the discontinuity meter.

Mr. Mordey, in reply, said his 1882 (? 1883) tests were made with open circuit transformers, and added that, even if the supposed fluctuations did exist, they were of no very great disadvantage.

Mr. Raworth considered the efficiency tests gave results too variable to admit of much confidence being placed in them, for the many tests made at the Brush works on various machines were so very regular that they had now ceased to make them. The method of taking the speed seemed open to serious objection, for the power may vary considerably during a minute. A well-calibrated tachometer would have been much more satisfactory. As regards breakdowns from defective insulation, his own experience in exhibition work proved that leaky roofs cause the majority of such accidents.

Replying to some remarks from Mr. Raworth, **Prof. Ayrton** said he had no desire to disparage Brush machines, and only wished to point out that the evidence of fluctuation obtained by the discontinuity meter received confirmation from Mr. Murray's results. He also added that the paper under discussion contained internal evidence of imaginary accuracy, for to speak of ordinary commercial measuring instruments agreeing to $\frac{1}{100}$ th per cent. was absurd; such instruments could not be read to the degree of accuracy implied by the statements made in the paper.

Prof. S. P. Thompson thought arc and incandescent machines should not be judged from the same standpoint, for as the saturation of the iron is entirely different, the former could not be as efficient as the latter. Referring to fluctuation of current, he said that the two kinds of arc machines in common use (viz., Brush and Thomson-Houston) had both few parts in the commutator, and open-coil armatures. The E.M.F. of such machines must fluctuate considerably, but the large self-induction of arc circuits tends to steady the current. His own experience, however, proved that small Brush machines give fluctuating currents, but he thought the currents from large dynamos working long arc circuits would be steadier. As an instance of the necessity for large self-induction in such machines, a case was quoted where a Thomson-Houston machine refused to do its work when the fields were separately excited. In concluding, the speaker said the relative values of magnetic force and permeability given on slip 14 were very disproportionate, and suspected they ought to be divided and multiplied by 10 respectively.

Mr. Cousens said he had had considerable experience with arc plants in the colonies, and had found the Brush machine very satisfactory. He had often noticed that the current decreased as the lighting continued, and that the lamps burn steadier as the time goes on. Cold weather also seemed favourable to steadiness. One of the chief mechanical defects he had experienced was the breaking of the commutator connections of shuttle-wound armatures, and when these were strengthened the wires on the armature broke. Of the latter phenomena he was unable to give an explanation.

Mr. Esson, speaking of the efficiencies, hot and cold, given in table C, said he was quite prepared for differences of 2 or 3 per cent., but not for 10 per cent., as in some cases was there shown. The value of the paper to electrical engineers would be considerably enhanced if the relation between the i.h.p. of the engines and the useful electrical power had been given. His own experience with Phoenix dynamos driven from countershafting showed that with arc machines 66 per cent., and with incandescent 71 per cent. of the i.h.p. was available at the terminals. These proportions could be increased by belting the dynamos direct to the engines. In conclusion, he protested against the idea that open-coil armatures were necessary for successful arc lighting, for ordinary Gramme armatures had been made to give 1,500 volts satisfactorily.

Mr. Kapp considered the table of efficiencies very interesting, and thought they deserved careful study. From table A the efficiencies of "thin-plate" armatures were decidedly greater than those with thick plates, thus showing the advantages of lamination. The objection to the use of thin plates—viz., expense, weakness, and space wasted by insulation—were not insuperable, for the additional expense was not prohibitive, and he was glad to hear from Mr. Mordey that the defects of weakness had been satisfactorily overcome. As regards waste space by insulation, he said that this need not exceed eight per cent., and that some makers had ceased to use any insulation between the plates. Speaking of the fluctuation of current, he thought all agreed that the E.M.F. of Brush machines fluctuates, and the effect of self-induction was to reduce (not destroy) the variations in the current.

Mr. Addenbrooke, who happened to be in Melbourne at the close of the exhibition, gave an account of the general appearance of the installation, which he characterised as very neat. From what he heard, the lighting was considered very satisfactory, the arrangement in the picture galleries being particularly good. He was also informed that the transformer plants supplied by Messrs. Ganz and Co. and the Thomson-Houston Company worked well. The boilers used were of a combined locomotive and marine type, with tubes and return flue, and the engines seemed to be an exact copy of Marshall's two-cylinder high-pressure type.

Mr. Preece said Mr. Murray had entrusted him with the care of the paper, and he was sure its reception would be very gratifying to the author. He himself would have liked more information about the behaviour of the arcs, and the amount of illumination employed. Speaking of his own experience in exhibition lighting, he remarked that in determining the power necessary, he totally disregarded the nominal candle-power of the lamps, and based his estimate on the

number of watts per square foot of floor space. As a matter of experience he found half a watt per square foot gives brilliant illuminations, and one-third of a watt was enough for most purposes.

Dr. Hopkinson (who was in the chair), in confirmation of Mr. Mordey's and Mr. Raworth's statements, said that his tests showed the Victoria dynamos to be very satisfactory, the efficiency being 92 per cent.

COMPANIES' MEETINGS.

BRUSH ELECTRICAL ENGINEERING COMPANY.

The statutory general meeting of this electrical engineering company was held on Monday at the City Terminus Hotel.

Lord Thurlow, who presided, observed that they must all know the circumstances in which the new company had been formed. He was now addressing the shareholders not only of the Brush Company, but those of the Falcon Engineering Company, and he thought he might almost say those of the Australasian Company also, that company having finally entered into an agreement with this Company, with certain modifications which were contemplated at the last meeting. The Board consisted of the Directors of the old Anglo-American Brush Electric Light Corporation, with the addition of a new member, the Duke of Marlborough, who was one of their oldest and most valued customers, who took the deepest interest in all electrical and engineering works. Besides the directors of the Anglo-American Brush Company they had on the Board representatives from the directorates of the two other companies. The amalgamation with the Falcon Company was now complete; and they were quite ready to issue their shares to the Australasian Company in exchange for their shares as soon as the patents had been assigned to the Brush Electrical Engineering Company. The purchase agreement provided that shares in this Company should be issued to the Australasian Company to the extent of £31,000, for which they would acquire the rights of that company in Australia, the Cape, and India. Certain deviations had been made in the original scheme, it now being optional to the new company until the beginning of next year to take over certain other assets of the Australasian Company. They were now carrying on the manufacture of cars and locomotives originally conducted at the Falcon Works, and he might add that the tools and shops there were admirably adapted for the manufacture of the various articles which the new company had to make for its own uses—motors, dynamos, and engines for driving electric lighting machinery. Another circumstance which induced him to look forward with considerable satisfaction to their future was the undoubted advance which electric lighting was making, not only in the metropolis, but throughout the whole of Great Britain and the civilised world. They knew that the Board of Trade were at the present time overwhelmed with work, and that they had under consideration 430 applications for provisional orders for electric lighting throughout the length and breadth of the land. When they considered what a vast amount of manufacturing plant and machinery of various descriptions which these orders meant—and he thought they might reasonably hope to get their fair share of the work—he considered that he had a right to say that it would be the fault of the Directors if they could not now bring the Company to success. They now had orders in hand far exceeding the work they had turned out during the whole of last year, and every day was bringing in fresh orders. Occasionally, indeed, they had been obliged to turn away orders, but they were doing their utmost to avoid having to do so.

In answer to **Mr. Weir**, the Chairman stated that they had taken over no patents in connection with electric lighting. Their men did both piece and day work.

PROVISIONAL PATENTS, 1889.

NOVEMBER 18.

18365. **Improvements in and connected with plates for primary and secondary batteries.** Justus B. Entz and William A. Phillips, 70, Market-street, Manchester. (Complete specification.)

18377. **Improvements in signal and telegraph apparatus.** Robert Armstrong, Lingerwood House, Lasswade, N.B.

18414. **Improvements in electrical tramways or railways.** John Hopkinson, 47, Lincoln's-inn-fields, London.

NOVEMBER 19.

18439. **Recording the strength of an electric current.** William Henry Dines, West End, Esher, Surrey.

18481. **Improvements in secondary or storage batteries.** Clement Payen, 323, High Holborn, London. (Complete specification.)

18521. **Improvements in telephone receivers.** Henry Thomas Tallack, 28, Hatton-garden, London.

18526. **Improvements relating to the transmission and reception of telegraphic signals and to apparatus therefor.** Henry Harris Lake, 45, Southampton-buildings, Middlesex. (Stephen D. Field, United States.)

NOVEMBER 20.

18550. **Improvements in electric heaters.** Edmund Simpkin, 24, Queen's-chambers, 5, Market-street, Manchester. (Watkins Leigh Burton, United States.)

18571. **Improvements in the construction of conduits for carrying electric light and other electric lines or cables.** James Charles Richardson and Henry McKenna, 23, Claremont-square, London.

18578. **Improved apparatus for registering the consumption of the electric current.** Samuel William Maquay, 55, Chancery-lane, Middlesex.

NOVEMBER 21.

18604. **The measurement of and regulation by electric currents.** John Perry, Charles Edward Holland, and Henry Bleckly Bourne, 4, Redington-road, Hampstead.

18638. **Improvements in the mode of driving electrical vehicles.** Alfred Dickinson, 77, Colmore-row, Birmingham.

18651. **A system of conducting and distributing at a distance electric currents of large quantity from a low-pressure continuous current generator.** John Alexander McMullen, 9, Warwick-court, High Holborn.

18654. **An automatic electrical device for signalling changes of temperature.** Robert Howe Gould and Emil Ubrig, 55, Chancery-lane, London. (Complete specification.)

18680. **Improvements in the construction of dynamo-electric machines.** Henry Hauser, 38, Chancery-lane, London.

NOVEMBER 22.

18700. **Improvements in connection with electric battery cells.** Thomas William Watson and Arthur Henry Watson, 4, Pall Mall, London.

18712. **An improved form of connection for electric lamps for stage battens, footlights, &c.** John Benjamin Verity and John Owen Girdlestone, 31, King-street, Covent-garden.

18740. **Improvements in couplings or clutches, more especially applicable to the driving of dynamo-electrical machines connected in parallel.** Frank King, 47, Lincoln's-inn-fields.

18743. **Improvements in cables containing electric conductors.** Sydney Pitt, 24, Southampton-buildings, London. (Anthony Dey, United States.) (Complete specification.)

18755. **Improvements in the manufacture of plates for use in secondary batteries or electrical accumulators.** Anthony Reckenzaun, 20, High Holborn, London.

NOVEMBER 23.

18768. **Improved arrangement for applying electro-motors to vehicles and for transmitting motion to the axles thereof.** Moritz Immisch, 52, Chancery-lane, London.

18795. **Improvements in or relating to dynamo-electric generators.** William Phillips Thompson, 6, Lord-street, Liverpool. (The Westinghouse Electric Company, United States.)

18817. **Improvements in electric mechanism for operating telephone call bells and annunciators.** Henry Birkbeck, 34, Southampton-buildings, London. (Frederick Wm. August Schneider and William Carl Zeidler, Canada.) (Complete specification.)

18821. **Improvements in electric baths or apparatus for applying electricity for medical or other similar purposes.** Gustav Gaertner, 47, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED

1888.

16129. **Electrical alarms.** Lansard. 6d.

18825. **Electric switches.** Cockburn. 8d.

18908. **Electric arc lamps.** Goodfellow and Charles. 6d.

18966. **Telegraphic transmitters.** Timm. 8d.

18978. **Storage batteries.** Bush. 4d.

19045. **Telephone call apparatus.** Handford (Western Electric Company). 8d.

19058. **Electric batteries.** Johnson (Gendron). 8d.

1889.

1112. **Telephony, &c.** Gwosdeff. 6d.

1113. **Telephony.** Gwosdeff. 6d.

3556. **Regulating current developed by dynamos, &c.** Firth and Crabtree. 8d.

11705. **Preventing loss of surplus electricity generated by dynamos.** Engelbach and Bright. 8d.

14290. **Elevated railways.** Lake (Cody). 8d.

15383. **Secondary batteries.** Heyl. 4d.

15446. **Electrical accumulators.** Currie. 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.	Name	Paid.	Price Wednesday
12 Feb. 1/2	Anglo-American Brush E.L.	—	4½
12 Feb. 2/0	— fully paid	—	5½
14 Nov. 0/4½	Con Telephone & Main ...	1	3½
27 July 10/0	India Rubber, G. P. & Tel.	10	19½
.....	House-to-House	4½	5
.....	Metroptn Electric Supply	—	3½
.....	London Electric Supply ..	5	4½
.....	Swan United	3½	5
2 July 12/0	Telegraph Construction ...	12	43½
2 July 6/0	— 6%, 1889	100	105
.....	National Telephone	5	6½

NOTES.

Venice.—A central station is to be established in the classic town of Venice for 15,000 lamps on the Westinghouse system.

Bombay.—The Bombay Tramway Company are intending to extend their lines—possibly a good opportunity for the introduction of electric cars.

Zurich.—The well-known firm of Escher, Wyss, and Co., of Zurich, with their branch at Lofsdorf, near Vienna, has been formed into a limited company.

Bisley Tramway.—The National Rifle Association are asking for powers to construct a tramway at Bisley, and authority is sought to run by electric traction if desired.

Telephonic Extension.—Portsmouth, Southampton, and Winchester are now in telephonic communication, and the trunk line is about to be extended to Bournemouth.

Society of Arts.—A paper will be read on Wednesday, December 11, at 8 p.m., by Mr. H. Trueman Wood, secretary to the Society of Arts, upon "The Paris Exhibition."

Telegraphs in China.—The Chinese Telegraph Administration are about to construct a line from Paoting-foo to Ili. It will cross the province of Shansi, and will be 1,500 miles in length.

Spain.—The town of Ronda, in the province of Malaga, Spain, will shortly be lighted by electric light. The concession was put up to public tender, which was decided upon Nov. 16, and the work is to be carried out at once.

Exeter.—The Electric Construction and Maintenance Company have informed the Council that they intend to apply in the next after the ensuing session of Parliament for a provisional order to supply Exeter with the electric light.

Gas.—A gasholder at Peterhead was blown over last week by a slight gale of wind, and its contents, some 25,000ft. of gas, were lost. The storage battery may claim a distinct advantage here over the more volatile gasholder.

Telephones in Italy.—The action of France with regard to telephones appears to be contagious, and it is now announced by an Italian contemporary that the Italian Government intend to monopolise the telephone system in that country.

Bilbao.—A limited company has been formed at Bilbao for the supply of arc and incandescent lamps. A site has been already purchased for a central station. The plant will be installed before the end of the year, and the public supply is expected to commence in February next.

Metz.—Some of the streets of Metz have been lighted with arc lamps for a considerable time by means of water power obtained from the River Moselle. It is now proposed to establish a central station for general supply, and applications for both arc and incandescent lamps are quickly coming in.

Mica in Conduits.—A new idea is to be tried in Boston for electric light conduits to prevent moisture or gas attacking the wires. The inventor fills each of the ducts with flaked mica, which thoroughly fills the whole space, but which is so yielding that a wire can easily be drawn through.

Berlin.—The electric lighting supply in Berlin is growing apace. The sanction of the municipal authorities has been granted to the Berliner Elektrizitäts-Werke to increase the central station now in process of construction to total amount of 28,000 h.p. The mains are all underground upon the Monnier system.

Burton-on-Trent.—It was reported at the Burton Town Council that the draft provisional order for the electric light had been before the committee, and it was stated that the light was proposed to be supplied at first to Wetmore-road, Horninglow-street, High-street, the Market-place, Bank-square, Station-street, and the station bridge.

Electric Tanning.—On a motion in the Chancery Division, presented by the British Tanning Company, to restrain Mr. Grothe from infringing their patent, Mr. Justice Stirling, before whom the motion came, refused, after hearing all parties, to give either side the victory, and simply directed the motion to stand over until the trial of the action.

Electric Light in Mining.—In the report of the Langlaagte Gold Mining Company it is stated that the installation of the electric light at the mine is rapidly approaching completion and will be working shortly. It is the intention of the directors to extend this system of lighting to the underground working, in order to ensure perfect safety in the mine.

Aluminium.—The Allgemeine Electricitäts Gesellschaft Edison, of Neuhasen, has just acquired the sole right in Germany of the manufacture of aluminium by electricity. They have recently exhibited their products at the exhibition of safety apparatus in Berlin, and it is this company who intend to introduce the employment of aluminium in the manufacture of the framework of arc lamps in the place of iron.

Zurich.—Several applications having been made for the total lighting of the town of Zurich, a technical committee was appointed, whose decisions have just been made known. The Oerlikon Company obtained the concession for the sum of 1,327,884f. The other tenders asked respectively: Messrs. Siemens and Halske, 1,793,426f.; Stirneman, 1,689,810f.; and the Telephone Society of Zurich, 1,014,316f.

Allahabad.—The proposal to light Alfred Park, Allahabad, has received an impetus, owing to Messrs. Walsh, Lovett, and Co. having introduced at their night-work, on the water supply scheme, an installation of six arc lamps of 2,000 c.p. The Lieutenant-Governor is expected to visit this installation, and this may result in the lighting of the park and such of the surrounding bungalows as require the light.

Manchester Telephones.—A new rival to the National Telephone Company is proposed to be started in Manchester as a co-operative telephone company, to begin business on the expiration of the Bell patent, which occurs in December, 1890. The co-operative company propose to charge £5, as against the £20 of present exchange. The Postmaster-General has already promised a license on the same terms as the existing company.

Pullman Electric Cars.—Not a small amount of work is now being carried out by the Pullman Car Company in the construction of the electrical cars for the various electric street railroads of America. Orders such as that for 10 complete cars for the line at Akron, Ohio, are being

received from week to week, and the business of supplying electric Pullman cars for tramways seems to bid fair soon to rank in importance with the manufacture of railway cars.

Italian Tramways.—A company has been formed in Italy for constructing and running an electric tramway, to communicate with Lodi and the neighbouring places, under the somewhat alarming name of the "Società Anonima della Tramvia Elettrica Lodi-Borghetto-San Colombano-Chignolo." The capital is to be half a million lire, and the machinery and apparatus are to be supplied by the Brush Electrical Engineering Company through their agent at Milan.

Dr. Joule.—On Friday last a special lecture was delivered at the School of Electrical Engineering, Hanover-square, to its students and friends, by Mr. E. T. Carter, (one of the staff), entitled "The Life of the late Dr. Joule, and his Work in Relation to Electrical Engineering." A reference was made to the movement in Manchester for a memorial to Dr. Joule, and various experiments and specially prepared lantern photographs and diagrams illustrated the lecture.

Exhibition at Frankfort.—A meeting of merchants, engineers, financiers, and scientists was held at Frankfort-on-Main on Saturday last, at which a proposal to hold an international electro-technical exhibition from June to October next year was adopted. The meeting also elected a committee to take the necessary steps for giving effect to the proposal, and agreed to a temporary scheme for providing the funds required. Mr. Siemens, Mr. Edison, and Sir William Thomson were elected honorary members of the committee.

Paris Railway Stations.—The undoubted success of the electric lighting of the Gare St.-Lazare seems to have inspired the other railway companies. It is now announced that the Gare de Malines, at Paris, is to be fitted with electric light, and the contract is put up to tender, and four companies have sent in tenders. The award is not yet made, but it is understood that the work will be commenced on the 1st January, and the whole installation is to be completed and in working order by the 1st February next.

Tenders for Paddington.—The Vestry of Paddington, as will be remembered, decided not to undertake the electric lighting of the district itself, but to make arrangements for placing it in the hands of one or two responsible electric companies. From the advertisement which appears in this number it will be seen that the draft provisional order or specification has been prepared and can be seen at the Vestry Hall, Harrow-road, and that the Vestry of Paddington now invite tenders for the right to light the borough by electricity.

"The Daily Graphic."—The most interesting preliminary number of the new illustrated daily paper, *The Daily Graphic*, which is to appear on January 4th next, has reached us, and is an admirable example of the constant progress of the human race. A front illustration shows one of their artists on a battle-field, seated on a waggon fitted with a huge coil of electric wire, busily sketching and transmitting his sketch by electricity to the office—a marvel as yet not realised, but fondly looked forward to by the proprietor as possibly soon to be a fact.

Sand Distributor.—An arrangement for the distribution of sand on the rails in front of electric cars is being

introduced by the Jordan-Mills Company, of New York. A system of levers is actuated by the driver's foot, the sandbox and valves being placed under the cars and well protected from the weather. The sandboxes are now fitted on a number of electric cars, among others being those of the Julien, the Daft, and the Electric Car Companies in America, and business overtures have been made to introduce them on the proposed electric tramcars in England.

Dundee.—At the meeting of the Dundee Town Council Committees, it was agreed, after a lengthened discussion, to obtain the opinion of Dr. Hopkinson, who has already acted as consulting engineer in the Bradford installation, as to the expense and all other matters connected with the carrying out of an installation in Dundee. At the adjourned meeting held on Wednesday, Dr. Hopkinson, who had made a tour of the city the previous day, reported verbally the cost of supplying the electric light to the central portion of the city. He favoured the project of an installation to supply 5,000 lamps.

Photographing Bullets by Electricity.—Rifle bullets are now photographed in their course by means of the electric spark. The camera is taken into a dark room, which the bullet is caused to traverse. As it passes the camera it is made to interrupt an electric circuit and produce a spark, which illuminates it for an instant and enables the impression to be taken. The wave of condensation in the air before the bullet and the rarefaction behind it are visible in the photograph, and can be studied by experts, thus enabling the form of ball or rifle which minimises the resistance of the air to be selected.

The Mahdi's Tongues of Flame.—The Mahdi seems to have been particularly fortunate, from a religious point of view, in having had a display of St. Elmo's fire, i.e. a brush discharge of electricity, from the points of his soldiers' spears, which greatly added to their religious fervour. Omar Saleh, in his recent letter to Emin Pasha, alludes, awestricken, to these "tongues of flame," saying "this we have seen with our eyes and not heard only." Several instances of the same kind have been noticed, with great interest but without the same awe, quite recently, by scientists on the Alps and upon Ben Nevis.

Bath.—At a special meeting of the Bath Urban Sanitary Authority, it was unanimously agreed that Mr. Massingham should be allowed to apply for a license under the Board of Trade. Some little difficulty has arisen with regard to the transfer of public lighting, as it appears that there is a gap between the time at which the gas company's contract terminates—namely, the 21st proximo—and the date at which Mr. Massingham's contract takes effect, which is March 25 next. The Surveying Committee had instructions to enter into some interim arrangement to prevent the town being left without public lighting.

Public Lamps by Storage.—It is stated that the recent crusade against overhead wires and high-tension currents in New York has resulted in the practical consideration of a system of supplying the public lamps by means of a storage battery placed at the foot of each lamppost. The question of economy, according to the *New York Sun*, has been "satisfactorily settled." The battery is sufficient to last two days of eight hours each, and is furnished with an arrangement to cut off the light after the required time of burning. It will, however, require a better authority than the *Sun* to assure us that the financial question is at all satisfactory.

Innsbruck.—The Gas Company of Innsbruck, the capital of the Tyrol, have taken the question of electric lighting boldly in hand themselves, and, with the co-operation of Messrs. Ganz and Co., of Budapesth, have established a central station for the supply of electricity in the town. The power is obtained from a waterfall of some 370ft. fall near the town. Two turbines, each of 150 h.p., have been fitted, and these drive two Zipernowski alternate-current dynamos of a total capacity of 160,000 watts. The current is generated at 2,000 volts, and the distribution is effected from several centres at distances of about $1\frac{1}{2}$ miles from the station, and the current is reduced to 100 volts or 50 volts for supply to the houses.

Paris Central Station.—A small central station has been started by M. Emile Pulsford, in the Faubourg Saint Martin, Paris, to supply electric light to the block of buildings comprised between the Boulevard de Strasbourg, the Boulevard and the Faubourg St. Martin, and the Rue du Chateau d'Eau. The station, at present, supplies some 1,200 lamps of 10, 16, and 20 c.p., at the price of 70f. (£2. 15s.) per 10 candles per year, and proportional tariff for higher powers. Only one arc lamp is supplied at present. The power is supplied by two Davey-Paxman engines of 70 h.p., and one semi-portable engine of 30 h.p., which drive the Gramme machines of modern type. The cables are run overhead, from house to house, without crossing the public streets.

Tynemouth.—Some little while back, the Tynemouth Corporation resolved to obtain parliamentary powers for the purpose of supplying the borough with electric light. At a meeting of the Council, held last week, however, it was agreed, on the recommendation of the Parliamentary Committee, not to proceed further with the application for a provisional order. The action of the Council is based upon the withdrawal from action in the matter by the public companies who had previously intimated their intention to apply for such powers. Their resolution, however, was not come to without a long and animated discussion, an amendment by Mr. J. P. Spencer favouring the application for a provisional order being lost by six votes only. It was stated by the town clerk that upwards of £21 had already been spent in advertising the project in two newspapers.

Wiesbaden.—The committee nominated to examine the question of the introduction of the electric light, by the establishment of a central station at Wiesbaden, has presented its report to the Municipal Council. The practical result of this report is, that there are serious difficulties in the way of the establishment of a central station in that town. The committee is of the opinion, first, that the town would suffer by the installation of a large machinery depot in its centre, and, secondly, they also think that means could be found to establish the station at some distance from the town. Finally, as the neighbouring town of Frankfort-on-Main is seriously considering the question from this point of view, it would be well to await the result of its experience and to profit thereby. The Council of Wiesbaden has approved this report, and the question stands over for further consideration at a later date.

Electric Motors.—While work in England with electric motors—which ought to be the most profitable of all electrical departments—is yet not much more than at a standstill, the progress from month to month in America is enough to put spirit into the most unbelieving of engineers. During the three months ending September 30,

1889, the orders received in the railway department of the Thomson-Houston Company alone, not including lighting apparatus or motors for mining or stationary work, amounted to 608 motors, with an aggregate of 8,455 h.p., and generators for railway work aggregating 4,710 h.p. This is at the rate of 52,660 h.p. per year in tramway motors and generators alone. During the first 15 days in October the tramway orders have aggregated 170 motors (2,550 h.p.), and 1,200 generator h.p., or a total motor and generator horse-power of 3,750, which is at the rate of 90,000 h.p. per year.

Newcastle.—We are glad to be able to announce that the difficulty with regard to the electric lighting companies in Newcastle has been got over in a very simple way, one which it would have been thought might easily have been carried out long ago. An agreement was drawn up and was sealed on Wednesday by the Council of Newcastle, which will enable the companies to go on with the laying of their underground cables. Both companies have had their plant laying idle now for some months, the difficulty being with reference to the payment of compensation to the Corporation if either of the companies should neglect to repair the streets after the laying of the cables, there being, it is stated, no legal provision in this respect. The agreement mentioned has removed the difficulty, and it is expected that electric light will be substituted for gas in the principal business places of the city in a few weeks' time.

French Regulations.—Every time any important work is to be done or expected to be done in Paris, the police authorities or some other equally self-important authority immediately brings out its "regulations," arranged like a book with chapter I., II., etc., etc. Regulations are well enough in their way and in moderation often absolutely necessary, but it appears that sometimes enterprise can be regulated out of existence. It seems that the concession for the lighting of the luminous fountain in the late exhibition grounds, together with the supply of electricity to the Esplanade des Invalides, part of the Boulevard Saint-Germain and the other broad streets converging to the Champs de Mars, was opened for tenders from private companies, but some of the clauses were of such a nature that not a single application for the concession could be obtained. It was therefore left to the Municipality of Paris to undertake the running of the station itself.

Scotch Corporations.—The Board of Trade have intimated that they are not prepared to give provisional orders except strictly under the Electric Lighting Acts. At Aberdeen it is feared that the effect would be to prevent the Town Council from making it a joint enterprise with or part of their gas undertaking, and raising money on the gas contingent guarantee rate, and that, therefore, it will have to form part of the police department. A notice for both a Bill and a provisional order has been given by the Aberdeen Town Council, in its three capacities as municipal, gas, and police authorities, to keep the matter open for discussion. It is suggested that the various Scotch corporations interested in this question should make a combined application to the Board of Trade, with the view of pressing the matter upon the Board at a personal interview, and urging them to bring in a Bill at an early date next session to amend the Electrical Lighting Acts, and thus remove the existing anomaly.

St. Helens.—A special meeting of the St. Helens Town Council was held last week to take into consideration

the question of applying to the Board of Trade for a provisional order to authorise the Corporation to supply electricity for public and private purposes within the present limits of the gas supply. Alderman Cook, chairman of the Gas Committee, explained that some few months ago the Corporation had notice from two electric lighting companies that it was their intention to apply for licenses to supply electricity within the borough for public and private purposes. Inasmuch as the Corporation possess the gas works, and had practically a monopoly of the public and private lighting of the town, it would be very inexpedient to allow an electric lighting company to enter into the town and supply electricity in competition with gas. The installation would cost £20,000, but before they committed themselves they must be satisfied that they could find sufficient customers. He moved that application be made for an order. Alderman Gamble seconded the motion, which was carried.

Chili.—We have insisted from time to time upon the great importance of cultivating the extension of electrical engineering in our colonies. Not less important is it for English manufacturers to be first in the field in countries for which there is, or can be made, a market for their goods. Of these, Chili itself is well aware of the advantages of the introduction of latest engineering improvements, and the Chilean Government have recently passed a law making numerous articles of manufacture duty free from January 1 next. These, besides machinery and implements for agriculture and mining generally, include iron or steel wire up to No. 14, copper or insulated wires for electric conductors, telephone and telegraph instruments, insulators, iron or steel poles and other apparatus for telegraphs and telephones, iron or steel material for railways, whether worked by mechanical means or by horses, portable railways, wheels, axles, waggons, and iron plates generally. The removal of the duty upon these articles ought to result in increase of business with Chili in the engineering and electrical trades generally.

Gulcher Company's Catalogue.—We have received the new catalogue of the Gulcher Electric Light and Power Company, Battersea. This catalogue is a very comprehensive one, ranging from the old Gulcher type of low-tension dynamo, and new types of alternate-current dynamos with transformers, and Gulcher arc lamps, projectors, switchboards, and apparatus, etc., to steam-engines of various makes, turbines, gas and petroleum engines, boilers, belting, cables, and accumulators. The catalogue is handsomely printed and full of good illustrations. It may be feared, however, that the Gulcher Company suffer, if anything, from an uncertainty of name. We understood, for one thing, that henceforward "Gulcher" was to be always spelt without the diæresis. It appears here in both methods. The name of the company is also given as Gulcher (New), and simply Gulcher, and again their alternating dynamo is named both "Battersea" and "Battersea (Fricker)." These, however, are minor matters, though perhaps a little puzzling to new customers. The catalogue contains very full details of all kinds of plant necessary for installations, and the practical instructions at the end for jointing cables will be found useful.

Halles Centrales.—The Paris municipal station at the Halles Centrales was opened last Sunday in truly Parisian manner. The opening ceremony was performed by M. Yves Guyot, chairman of the Paris Municipal Council, and was the occasion of a brilliant fête, with festivities and dancing, kept up all the night. A large

muster of the poulterers and fishwives in rich dresses, lace caps, and solid ornaments, attended to greet the chairman and present huge bouquets, and large numbers of the populace also assembled to honour the occasion and enjoy themselves. The streets were lighted with some 2,000 lamps. Both direct and alternate currents are employed, as described in the article last week. The Municipal Council wish to thoroughly satisfy themselves as to the comparative cost of the two systems, and it is understood that they intend eventually to increase the output of the station to 1,000,000 lights. The light is already so much in demand that it will be necessary very shortly to increase the plant, and a credit of a million and a half francs will, it is thought, be asked for. It is interesting to note that this is the first occasion on which the Municipality of Paris have directly themselves undertaken the working of any manufacture or business.

Alpha Arc Lamps.—The "Alpha" arc lamp, described by Prof. Silvanus Thompson in his Society of Arts lecture as the "electrical engineers'" lamp, has been fitted with marked success in the new premises of Messrs. John Barker and Co., of Kensington. It will be remembered that the feeding apparatus of this lamp is controlled by a small electromotor, as already described fully by us (vol. III., p. 330), an arrangement which makes the burning remarkably steady. Messrs. Barker, who are well-known upholsterers and universal providers for the Kensington world, have lately added to their already very extensive premises, and the new premises have been fitted up by the Planet Electrical Company, the makers of the "Alpha" arc lamp, the current being obtained from the mains of the Kensington and Knightsbridge Electric Lighting Company. A grand reception and ball was given on Monday last, for friends and customers to examine the premises, the lighting, and also a fine display of antique furniture purchased at the recent Paris Exhibition. The reception and ball were very fashionably attended. The ground and first floors were lighted by 42 "Alpha" arc lamps, taking five amperes, and running two in series from the 100-volt constant current circuit, and the rooms above were lighted by seven Sunbeam lamps of high candle-power and about 60 small incandescent lamps. The installation was running without break or hitch from 4 p.m. on the day in question till 2 a.m. on the following morning, and everyone seemed pleased with the exhibition.

Electrical Inspector for London.—At the weekly meeting of the London County Council on Tuesday the Highways Committee reported that the electric lighting legislation of last session imposed certain duties and obligations upon the Council, and the committee had had under consideration the manner in which these were to be discharged. The committee recommended that they should be authorised to obtain premises suitable for an electric testing station, and also to obtain and fix, at a cost of about £2,100, the necessary apparatus for the station, and that a competent person be appointed, at a salary not exceeding £200 a year, to discharge the duties of inspector under the Electric Lighting Acts. The electric lighting companies were required, before commencing any works which they intended to carry out in the public streets, to serve notices upon the Council, with plans showing how it was proposed to carry out the work. Several such notices had been dealt with by the Council, which had attached to its approval certain conditions as to the manner in which the work was to be done. There were at present, however, no means of ascertaining that the conditions imposed by the Council were

complied with; and the committee were of opinion that a person should be employed to supervise the works of the companies with a view to ensuring such compliance, and they recommended that a person be appointed at a salary of £3. 3s. a week to supervise the works of the electric light companies in the public streets, and to see that the requirements of the Council were complied with. It was decided that the inspector should be in the engineer's department, and the report of the committee was approved.

Hastings.—An enterprise of considerable interest is to be undertaken by the Corporation at Hastings. This is the utilising of the waste heat-energy of the dust destructor for the supply of steam power to be used for lighting the whole sea front from All Saints'-street to the Marina. The Lighting Committee has visited the works where the destructor is situated for the purpose of settling upon the method to be adopted, accompanied by the borough surveyor and Mr. C. C. Keep, representative of Messrs. Manlove, Alliott, and Co., of Nottingham, who supplied the destructor. The temperature attained is as high as 2,000deg. F., and the heated gases are conducted through the tubes of a multitubular boiler, generating a pressure of 80lb., and giving some 35 h.p., which is used at present in part for pumping salt water. Some 15 h.p. more can be saved by covering the pipes with non-conducting composition. There are also two Lancashire boilers, hitherto used, but lately dispensed with, which it is proposed again to employ. The Corporation propose to run 50 arc lamps along the sea front by these means, the two Lancashire boilers working together with the destructor for the first hours of the evening, from dusk to 11 p.m., and the destructor boiler alone supplying the light after that time. The destructor at present costs £250 a year; but it saves some £200 a year already in fuel for the salt water supply, and some £100 a year is also received for clinkers and the sale of useful refuse. It is now proposed to charge £150 a year towards the expense of public electric lighting, so that it is seen that if the surplus power of the destructor can be utilised in this way, the destruction of refuse, in many places a great expense, can be worked by corporations at a very considerable profit—a matter of infinite satisfaction to ratepayers. We hope the installation will be satisfactorily carried out.

Frosting Lamps.—The portable incandescent lamps used on board the Pullman special train all have frosted or "ground" bulbs, prepared in the glass department of the Pullman works by suspending the bulbs in a solution of so-called "white acid." Mr. A. H. Bauer has suggested the employment of the Planté process for securing delicate tracings on the lamps, or, in fact, on any glass, namely, to cover the glass with a saturated solution of nitrate of potassium (pure saltpetre), and trace the design with a finely-pointed platinum pencil connected to one pole of a storage battery, the other pole being connected to the glass. "F. de L.," writing in the *Electrical World* on the subject of frosting globes, says this white acid, which can be obtained from druggists in leaden flasks, can be prepared by slowly mixing equal parts of hydrofluoric acid and soft water in a leaden or rubber vessel, and allowing the same to stand till cool—some ten or fifteen minutes—always adding the acid to the water, and not the reverse. Then carefully drop small particles of carbonate of ammonia into the solution till all foaming ceases, when the solution is ready for use. In using the preparation it is well to preserve the fingers by anointing them with vaseline. Another and

more simple and easy method, if a temporary frosting only is required on a globe, is to make a saturated solution of sulphate of magnesia (Epsom salts) in clear water; strain the solution to remove any minute particles of dirt, and then dip the bulbs therein; drying and dipping again, repeating the process two or three times till the desired effect is secured. As three pennyworth of Epsom salts will furnish solution to frost 100 lamps, it merely requires a little patience to secure the most beautiful effects, almost identical in appearance with the superior class of work. But bulbs thus coated can only be used on one or two occasions, and must be handled with extreme care. For parties and receptions it answers the purpose well, and has an economical feature in that the solution costs practically nothing, and the frosting can be entirely removed by a moment's washing, thus leaving the glass clear for treatment with tints or otherwise. This solution of sulphate of magnesia may be tinted with colours that will dissolve in water.

Contract for Lighting the City.—A meeting of the City Commissioners of Sewers was held at the Guildhall on Tuesday. A report was brought up from the Streets Committee relative to the tenders for electric lighting and recommending that, inasmuch as the tender of the Anglo-American Brush Electric Light Corporation was in accordance with the specification based upon the conditions agreed to by the Commissioners on February 26 last, a contract be entered into with that corporation for lighting the central district, as referred to in the committee's printed report of the 30th of July last. In reply to Mr. Harris, Mr. Day, the chairman of the committee, said that the contract was for 21 years, and the cost per lamp per annum was £26. Mr. Harris said he objected to the report on many grounds. The scheme was not of a comprehensive character. The Commission meant that they were to have a comprehensive scheme for the lighting of the whole City. He pointed out that the contract was determinable at the end of seven years, and contended that the company could throw them over at the end of that period. The company was at present applying to Parliament for a provisional order for lighting the whole City. In the side streets glow lamps—that was to say incandescent lamps—would have to be used. The cost would be increased if they lighted the side streets with glow lamps. He thought they ought to give every facility for having private lighting in the City as soon as possible. With reference to the arc lamp, he contended that the statement that it was equal to 2,000 c.p. was inaccurate. Mr. Judd asked whether the statement that the tender was in accordance with the specification was correct, and if there were any variations or modifications what they were. Mr. Day, the chairman of the committee, replied that there were no variations or modifications. The Chairman of the Commission (Mr. Manners) said the Anglo-American Brush Electric Light Corporation's tender agreed absolutely with the specifications. Mr. Rose Innes spoke in support of the committee's report, and Mr. Pannell said he thoroughly agreed with the recommendations of the committee. Mr. Williamson also spoke in favour of the report, and remarked that if electric lighting were established in the City it would have the effect of bringing down the price of gas by one-half, and it would give the ratepayers the choice either of having the electric light or gas at a reduced rate. The report of the committee was then agreed to.

ON THE HEATING OF CONDUCTORS BY ELECTRIC CURRENTS.*

BY A. E. KENNELLY.

Although the best economical dimensions of a conductor employed to transmit power are determined by Sir William Thomson's law that that portion of the cost rate depending directly upon the cross sectional area of the conductor should equal the average cost rate of the power it absorbs in its duty, and although, at the existing prices of copper and of power, such a conductor must be very heavily loaded to acquire a dangerously high temperature, yet not only may its limits of safe capacity be strained by occasional pressure, but it is well known that in practice economy is not the only factor that determines a conductor's size, since the necessity, for example, of maintaining a constant difference of potential over an entire network of electric light mains under wide variations of load may sometimes clash with the conditions of economy in their transmission or even of safety in their temperatures.

Notwithstanding the consequent importance of a complete knowledge of the safe carrying capacity in conductors under all practical conditions of service, the subject has not, apparently, received the attention it deserves, and the simplicity of the law which determines the generation of heat in an active conductor seems to have caused the complexity of the laws governing the dissipation of that heat, and thus the limiting temperature, to escape the full notice of practical men. The most important published contributions to the subject appear in two papers, one by Mr. W. H. Preece, to the Royal Society, in March, 1888, and the other by Prof. G. Forbes, to the London Institution of Electrical Engineers (March, 1884). The former deals principally, however, with the fusing currents of wires for different metals and diameters, while the latter is almost exclusively devoted to the theoretical treatment of the subject. Had the experimental data of Prof. Forbes's paper been as exhaustive as its mathematical investigation was complete, there would probably have been little left to add or amend from an engineering point of view; but the vital numerical coefficients it adopts are taken from experiments on the emission of heat, which, however accurate and valuable in themselves, are not fairly applicable to the conditions of conducting wires, and which, in their published form, tend rather to conceal than to elucidate the principles underlying the subject. The fact remains that none of the existing textbooks or tables up to the present date give with any pretension to accuracy the carrying capacity of wires consistent with safe temperatures, in clearly tabulated form, or any clear conception of the variation the limit undergoes with change of environment—empanelled, free, or out of doors. In addition to this, the rule of the British Board of Trade for installations within doors has been pointed out by Prof. Forbes and others to be very uneconomical for small wires and actually unsafe for wires of a certain, though perhaps unusual, diameter.

To determine some of these unknown quantities, and particularly with a view to obtaining the necessary data for the fire insurance offices, the Edison Electric Light Company, of New York, recently instituted a series of experiments at the laboratory of Mr. T. A. Edison, in Orange, N.J., and with their permission the results obtained are now published. Not only have satisfactory general rules been arrived at for the safe carrying capacity of conductors, but the numerical coefficients in the formulæ given by Forbes have been determined with a fair practical degree of accuracy, while the field has been opened for further useful investigation.

The experiments were made on conductors under three different conditions:

1. With insulated copper wires encased in wooden panelling to represent house wires.
2. With copper wires, both bare and covered, suspended on poles in the open air to represent overhead service.
3. With copper wires and strips suspended across a room to represent the conductors in an electric light station, and also to form a connecting link between the two previous conditions.

* Abstract of report read before the Edison Convention at Niagara Falls, August, 1889.

The elevation of temperature produced in the wires (whose conductivity varied from 97 to 101* per cent.) was in every case determined from the increase of their resistance observed after the experimental current had been passed through them sufficiently long to practically attain a limiting permanent temperature. This period of time was found to be about ten minutes with the panelled, and some two minutes with the suspended wires. With the former, a steady increase of resistance, which according to theory would continue for all time, could be noticed for as much as 30 minutes, but it was estimated that the temperature elevation reached in ten minutes was 97 per cent. of its full ultimate value, and the greater accuracy attained by longer intervals of flow would not have repaid greater loss of time, especially as the quality of the wooden panel, its thickness, form, and position, would practically involve commensurate variation in results.

It has been sometimes believed that the temperature elevation computed from the rise of resistance would be somewhat in defect owing to the gradient of temperature from the centre to the circumference, and the cooling of the external surface. Analysis shows, however, that this source of error is too trivial to be taken into account, for if θ be the difference of temperature in degrees centigrade maintained in the permanent state between the axis of a wire and its exterior, then it will be found that

$$\theta = \frac{\rho}{J K} \left(\frac{C}{O} \right)^2;$$

where ρ is the resistivity of the wire,

C is the current it carries,

O is its circumference,

J is Joule's equivalent, or 42 megalergs,

K is the thermal conductivity of the metal,

all being expressed in absolute measure.

For a copper wire of one centimetre in circumference, carrying 100 amperes with $\rho = 2,000$ and $K = 1.1$, $\theta = \frac{1}{220}$ of 1 deg. centigrade.

Empanelled Wires.—Two 20ft. lengths of pine panelling were made, and in all the tests these panels rested with their broad bases on the wooden floor of the testing-room. In the smaller size 12 wires, ranging from 0.0185in. (0.047 centimetre) to 0.119in. (0.302 centimetre) diameter, were successively tested, one side only of the panel being occupied at one time. In the larger size 12 larger wires were tested, ranging from 0.119in. (0.302 centimetre) to 0.445in. (1.131 centimetres) diameter, generally two at one time, one in each compartment, so that the observations may be said to extend to diameters of nearly half an inch, or from wires whose resistance per metre varied from 0.019 ohm to 245 microhms at zero C. All the resistances in the tests are expressed in legal ohms (106.0 centimetres).

The increase in the resistance of the wires due to their heating was determined in the cases of all but the very smallest by that very accurate null method, in which the variable potential difference between the ends of the tested wire is balanced against the constant potential difference between the ends of an invariable platinoid resistance in the same main circuit, as shown diagrammatically in Fig. 1. This standard resistance was formed by a grid of 40 parallel platinoid wires, each 8ft. (244 centimetres) long and 0.031in. (0.079 centimetre) in diameter, stretched in a wooden frame between copper rods. The joint resistance of all these wires was 0.0499 ohm, and their large total surface of 374 square inches (2,410 square centimetres) and small coefficient of temperature variation (0.021 per cent. per degree C.) effectually maintained the resistance constant within at least 0.1 per cent. under all current strengths employed, especially as with the stronger currents the grid was connected with its two halves in multiple by letting the current enter at a third copper rod in the centre, and divide among the 40 wires on each side, the total resistance in this condition being 0.0121 ohm.

* Samples of copper offering a conductivity of as much as 104 per cent. of the original Matthiessen standard are stated to have been produced within the last few years, showing that the value of the standard needs revision under improved forms of chemical and mechanical treatment.

To balance the potential differences supplied by the wire and the grid, a dead-beat differential mirror galvanometer was employed. It was carefully adjusted for differential perfection, until five volts connected with its coils in opposition series produced a barely perceptible deflection. The resistances and balance of the coils (about 2,700 ohms each) were observed before and after each test. During the observations one of these coils was connected with the panelled wire, and the other in opposition with the platinoid grid. The initial difference between the opposed currents thus acting on the needle when the first feeble current was sent through the main circuit, was reduced to vanishing point by inserting resistance in the circuit of preponderating influence. Under these conditions the resistance of the wire became determined, and its terminal potential difference exactly balanced on the galvanometer that from the grid. As the current in the main circuit was successively increased this balance became upset by the corresponding rise of temperature, resistance, and terminal potential difference of the wire, necessitating readjustment of the inserted resistance, while the extent of this readjustment supplied all the data for the calculation of the change. This method was found to be very sensitive, and allowed the rise of temperature to be observed in a convenient manner for estimating the approach to limiting permanent state, while all slight variations of the dynamo-testing current were eliminated, since their effect was equal and opposite on the galvanometer circuits. The temperature elevation was carried up to 100deg. C., except in the case of the largest wires.

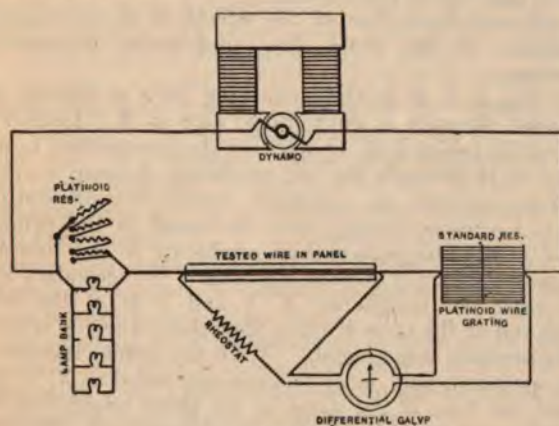


FIG. 1.

The strength of the current passing in the main circuit through wire and grid from the laboratory 110-volt dynamo was adjusted by platinoid resistances for the feebler currents, by banks of Edison lamps for the stronger, and by a set of overhead wires for the strongest of all, the limit reached being 300 amperes. It was measured by means of a potentiometer, connected with the grid and also by at least one ammeter or dynamometer in the main circuit, whose readings were taken as a check upon the former. About one reading of the current per minute was observed, and the mean taken as that of the average current flowing during the period. The potentiometer employed its own working battery, mirror galvanometer, and Clark standard cell. The potentiometer and ammeter are omitted in the diagram.

A NEW VIEW OF TELEPHONE INDUCTION.*

BY J. J. CARTY.

One of the most peculiar developments connected with the introduction of the telephone was the presence of remarkable sounds which were heard when the telephone line was of any considerable length. Sometimes it sounded as though myriads of birds flew twittering by; again, sounds like the rustling of leaves and the croaking of frogs could plainly be heard; at other times, the noise resembled the hissing of steam and the boiling of water. Even a

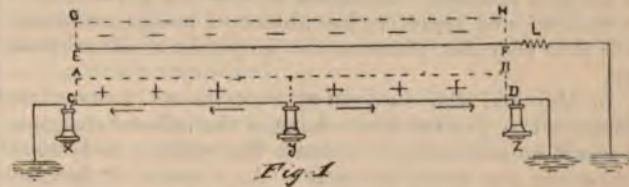
display of Aurora Borealis causes powerful currents in the telephone.

At one time, I think it was in 1882, during the prevalence of sun spots and after the appearance of a comet, the auroral current became so strong on a line from Boston to Brockton as to operate a miniature arc light which I improvised out of a pair of lead pencil carbons and connected into the line.

Some of these disturbances have been more or less satisfactorily accounted for by assuming differences of potential at the two ends of the line, by the sudden heating or cooling of the line, and by the passage of electrified bodies of air or clouds.

Another very curious effect was observed when the first two telephone wires were run parallel to each other on the same cross-arm for the distance of even a few miles. It was found that although the insulation of the lines was high, a conversation carried on over one wire could plainly be heard on its neighbour. This overhearing is commonly called "cross-talk." As the number of telephone wires increased, and their bunching together in cables became necessary, it was found that, in addition to the cross-talk, there was another element of trouble added, which was due to the electrostatic effect of the cable, and caused the voice to be transmitted in an indistinct and muffled manner. This evil exists to such an extent that where cables are used the speaking limit is soon reached.

While a study of the strange noises heard in the telephone might be of interest, I shall in this paper limit myself to the consideration of cross-talk and to the action which takes place when wires are bunched in cables. In the simple case of inductive cross-talk first cited, in which two telephone wires are strung parallel on the same cross-arm, the presence of cross-talk is said to be due to dynamic or current induction; that is, if a current commences to flow in one of the wires from north to south, it will at that



instant cause an induced current to flow in the other wire in the opposite direction, from south to north. As the telephone current is constantly changing its direction and strength, this explanation seems to apply and is the one given in the textbooks.

This is the kind of induction referred to in the law of Lenz, and applies to induction coils and to parallel wires when the current is of sufficient strength. I shall speak of this hereafter as electromagnetic induction. To-night I shall describe some experiments which seem to prove that the induction between telephone wires is due to electrostatic rather than to electromagnetic action.

* I will first show a case of electrostatic induction between telephone wires in which there is a neutral point at the centre of the secondary wire, at which point there is no induction, while at the ends marked inductive effects are noticeable.

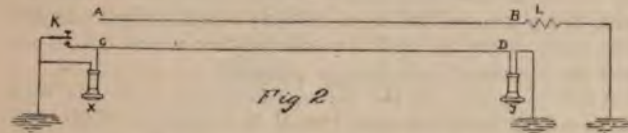
In Fig. 1, E F and C D are two well-insulated parallel telephone wires, each 200ft. long, and placed $\frac{1}{2}$ th of an inch apart. E F is open at one end and connected to ground at the other through a Blake transmitter, L, in the ordinary manner. In front of the Blake transmitter I place a vibrating tuning-fork, which acts on the transmitter in the same manner as the voice, and which produces impulses on the line E F of the same strength as voice currents. At the centre of the line C D we have the telephone Y, and at the extreme ends the telephones X and Z. With the tuning-fork at L in operation, tones are heard at X and Z, but the middle telephone, Y, is silent. A study of the changes of potential produced in the wire E F by the transmitter will

* In explaining an experiment of Mr. Culley before the Society of Telegraph Engineers in 1875, Mr. Preece pointed out that in a certain telegraph line subjected to induction from a neighbouring telegraph line, there was a neutral point. I can find, however, no reference to this in Mr. Preece's book on "The Telephone," and its practical application to telephone induction seems to have been lost sight of.

* Paper read before the Electric Club, New York.

give us an explanation of this phenomenon. As is well known, the telephone current is an alternating one, and the potential of the line E F varies constantly, and is changed from positive to negative many times per second. The wire E F being open at E would be at the same potential throughout. It is assumed that at a given instant the height of potential at F would be represented by the dotted line F H; then the potential at E would be represented by the dotted line E G, and the total charge on E F would be represented by the rectangle E G H F. We will assume that this charge is of the minus sign. The existence of this charge on E F presupposes the presence of a charge of opposite sign on C D, which would be represented by the rectangle A C D B.

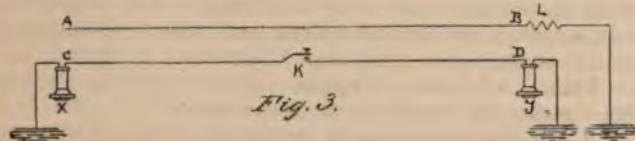
Now, suppose the potential on E F becomes zero, owing to the operation of the transmitter, then the whole charge on E F gets to earth at the grounded end of E F, but the charge on C D has two paths to earth, one at C and the other at D. This results in two currents, as shown by the arrows, one flowing to earth through the telephone X and producing sound at X, and the other flowing to earth through the telephone Z and producing sound at Z. No



current flows through the telephone Y, and consequently no sound is produced therein. Again, changing the potential of E F causes a corresponding set of currents, but in opposite directions to those first described, meeting in the centre and producing no sound in the centre telephone, but causing the end telephones to give out sounds the same as in the first instance. Inasmuch as the line E F is opened at one end, and therefore has almost an infinite resistance, it is clear that this phenomenon is purely an electrostatic one.

In this and the succeeding experiments I have not attempted to give the exact shape of the induced charge, as it would unnecessarily complicate the subject, and would not in any way affect the result. As a matter of fact, the dotted line A B should slope off from the centre towards the ends.

With the line E F grounded through an ordinary subscriber's line and instrument, the effect is the same as when the line is open, and the neutral point is still found. This is because the telephone current, even when flowing in a close circuit, is so weak that it is not capable of producing

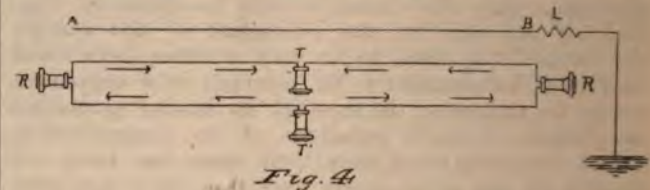


a magnetic field of sufficient strength to affect the neighbouring wire, or the magnetic effect is so small that it is obliterated by the movement of the static charge. For convenience in some of the succeeding experiments, the disturbing wire will be shown open at one end.

If there is no current flowing at the neutral point, opening the wire at that point should have no effect on the telephones located at the ends. In Fig. 3, A B is the disturbing wire, with the transmitter, L, arranged as before; K is a key located at the neutral point of C D. With the transmitter, L, in operation, no change is produced in the tones heard at the telephones X and Y by opening and closing the key, K. If this induction were electromagnetic, opening the line C D would prevent current from flowing in any part of the circuit. In Fig. 2 we have another proof of the electrostatic nature of telephone induction. A B is the usual disturbing wire with its transmitter, L. C D is the secondary wire with the telephones X and Y located at the ends, as in the previous experiment. By means of the key, K, the telephone X may be cut in and out of the circuit. With the key open, the usual tones are heard at X and Y. Now, if the induced current flowing

in the circuit C D is due to electromagnetic induction, upon short-circuiting the telephone X, and thereby reducing the resistance of the circuit C D, the strength of the induced current should be increased and the tone at the telephone Y should be correspondingly louder. But this is not the case, as on closing the key the sound at Y, instead of being increased, entirely disappears. This is because the charge on the wire C D finds an easy path to earth through the key, and such a small portion of the charge goes to earth through the telephone Y, that no audible effect is produced therein.

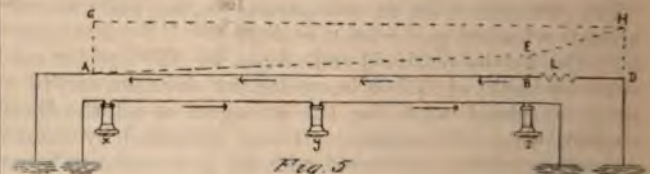
Fig. 4 shows the disturbing wire, A B, arranged as before, but the secondary wire instead of being put to earth at both ends, has its circuit completed by a second wire placed outside of the field of A B. With this arrangement, neutral points are found at T and T', while the usual disturbances are heard at telephones R and R', located at the ends. In this case a movement of the static charge takes place in the metallic circuit, causing at one moment a set of currents starting from T' in both directions through



the end telephones and meeting at T, and at the next instant the reverse takes place.

I will now show some of the effects of electromagnetic induction, at the same time suppressing electrostatic induction.

In Fig. 5, A B is the disturbing wire as before, but grounded through a short thick wire at A. Instead of placing the tuning-fork in front of the transmitter, L, and acting on it through the air, producing delicate currents like voice currents, an automatic circuit breaker and five cells of Leclanche battery were connected in the primary circuit of the transmitter, thus producing in the line A B alternating currents of great strength. The secondary wire containing the telephones X, Y, and Z is of the same length and at the same distance from the disturbing wire, as in the previous experiments. With the circuit breaker at L in operation, loud musical tones are heard at X, Y, and Z, and the tone is the same in all three telephones, the neutral point in this case having disappeared. This is a true case of electromagnetic induction, because short-cir-



cuiting the telephone Y increases the sound in the remaining telephones and leaving the short circuit on Y, and short-circuiting the telephone X, still further increases the sound at Z. This latter experiment furnishes a most striking contrast to the result obtained in Fig. 2, where by short-circuiting the telephone X, the sound was completely removed from the telephone at the other end of the line.

Another proof that this is electromagnetic induction is found in the fact that if the line be opened at Y, the sound disappears from all the telephones. If the line A B were opened at A, the potential along the line would be constant, and the charge which A B would take would be represented by the rectangle A G H D, but when the line is grounded at A through a low resistance, there is, of course, a fall of potential along A B; the principal drop, however occurring in the secondary coil of the transmitter, L, the line B E representing the height of potential at the terminal of the coil, and the electrostatic effect which the line A B would have is represented by the triangle A E B. This triangle, although exaggerated in the diagram, is still much smaller than the rectangle A G H D, and explains the absence of electrostatic induction between the wires, while

the powerful current generated in L, and the comparatively low resistance through which it has to flow, accounts fully for the electromagnetic effects observed.

I have made a large number of laboratory experiments and observations on actual telephone lines, all of which point strongly to the conclusion that electromagnetic induction does not exist in telephone lines outside of the telephone and transmitter. This view of the subject applied to the theory of transpositions of metallic circuits and to the action of wires in cables gives the only satisfactory explanation of observed phenomena.

Now, we come to the important question: Can this electrostatic induction be prevented? In answer to this, it can be said that the cross-talk due to electrostatic induction can be eliminated by properly-constructed metallic circuits. But there still remains the muffling effect referred to in the first part of this paper. This is sometimes called "electrostatic retardation," and comes in wherever two telephone conductors are run close to each other for any great distance. Where telephone wires are strung upon poles and are at a distance of a foot or more from each other this action is very small, but where they are bunched together in cables, a hundred or more within a 2in. pipe, it is very great. It is a curious fact, however, that the amount of this trouble, other things being equal, depends on the character of the insulating medium or dielectric, as it is called, but is independent of its specific insulation resistance, the induction being less when air is used as an insulator than with any other substance among the materials adopted in practice. Dry cotton, paper, and silk rank next to air in this respect, but when gutta-percha or any of the rubber compounds are used, the induction is much greater than with the other materials mentioned. This peculiar property of an insulator—i.e., the facility with which it allows induction to take place through it—is called its "specific inductive capacity." In the present state of the art, then, the only way to overcome electrostatic retardation, after having an insulator or dielectric of the lowest specific inductive capacity, is to increase the distance between telephone conductors. It is evident that in underground systems this distance can never be great. In all of our large city underground systems the space which is allowed for each wire is $\frac{1}{125}$ of an inch.

This putting wires underground in cities is the only bar to a universal system of telephony, and if direct air lines were built, New York and Chicago would be placed within speaking distance of each other at once.

To place telephone wires underground and maintain the same efficiency as in overhead lines would require an insulation on each wire of over two feet in thickness, and instead of getting 50 pairs of wires into a 3in. pipe, as at present, a tunnel occupying half the street would be required for one cable alone. When we consider that a telephone office of even moderate size would require about 100 such gigantic cables, it is seen how almost hopeless the case becomes.

Most engineers think that this difficulty is inherent in the problem, and that the electrostatic action can only be overcome by separating the wires as already stated.

In view of the recent researches tending to give us a deeper knowledge of the nature of electricity which have been conducted by Hertz and others, I think there is reason to hope that some other way out of the difficulty may be found. You are all, no doubt, familiar with those celebrated experiments wherein electrical undulations of many million times per second were produced, and, although they were transmitted along a conductor with the velocity of light, yet they followed each other with such rapidity that nodal points were produced, the location of which determined the length of the waves. These waves have been produced in various ways, and by means of large prisms of pitch and by metallic mirrors they have been refracted, focussed, and reflected. In fact, they have been found to obey much the same laws as light waves.

I think it must follow from these experiments that our disturbing wire, A B, is throwing off, laterally, waves of great length, and that these waves impinging upon the adjacent wire, C D, produce the various inductive effects observed.

Now, if by some means these waves could be deflected from their course and prevented from falling on the wire C D, it follows that there would be no disturbance whatever produced therein. We know that if these waves were of the same length as light waves, this action could be prevented by the interposition of a properly-shaped lens of glass, or by a mirror, or if they were of the length used in Hertz's experiments a lens of pitch or a metallic mirror would have the same result. Now, although the telephone waves are of great length, it seems possible that by interposing a properly-shaped dielectric or combination of dielectrics, that an interference or refraction might be produced which would have the desired result.

This electrostatic problem is one of the most important, and until within a year or two the least studied, and is at present the least understood of all the various difficulties with which we are confronted, and the reward which awaits its proper solution is greater than that which fell to the lot of the inventor of the telephone itself.

CORRESPONDENCE.

A NEW STANDARD RESISTANCE BOX AND WHEATSTONE BRIDGE.

TO THE EDITOR OF THE ELECTRICAL ENGINEER.

Sir,—We should feel obliged if you would kindly insert the following in the next issue of your paper.

In your issue of the 29th ult., under the heading of "New York Notes," there is a description of "a new standard resistance-box and Wheatstone's bridge, designed by Prof. W. A. Anthony, which embraces some novel and valuable features," brought out by Messrs. James Queen and Co., of Philadelphia.

We feel sure that this claim on behalf of Prof. Anthony must be made without his authority; we can hardly think that he would make claims, on his own account, to novelty in the points mentioned.

Resistance coils have been made with the blocks in rows instead of in dials, by London makers, for at least 15 years. It is quite a matter of opinion as to which form is the better.

The fixed double-plug reverser is very old. On ordinary plug coils it was introduced by Colonel Mallock, of the Indian Telegraph Service, as far back as 1872; whilst, in 1878, we adapted it to a special dial coil for Mr. Herbert Tomlinson, of King's College, and have continued to fit them on such coils up to the present time.

The "temperature coil" was introduced by Mr. Herbert Taylor about the year 1876, and we have continued to fit them on dial coils ever since that time.

Both of the last-named "novelties" have been described in our catalogue for more than 10 years.

When Prof. Anthony visited London, in 1881, we had the pleasure of showing and describing to him a dial coil, similar to Mr. Tomlinson's, which was fitted with fixed double-plug reverser and temperature coil; and resistance coils, having all the features described, were shown in the British section of the Paris Electrical Exhibition of 1881, which, if we remember rightly, Prof. Anthony visited.—Yours, etc.,

ELLIOTT BROS.

London, W.C., Dec. 2, 1889.

Boston (U.S.) Tramways.—The system of electric tramways which is being fitted up at Boston, seems to bid fair to be at once the largest and most complete in the world. The system employed is the Thomson-Houston with overhead wires. Some 5,000 neat steel poles are being fitted up along the streets, and large gangs of men are at work. One section has been open to the public, and sixteen cars are running, a temporary station having been erected. This contains five engines of 250 h.p. driving fifteen 80 h.p. Thomson-Houston dynamos, but some idea of the extensive nature of the full scheme is seen when it is mentioned that the permanent station, now in progress, will contain ten 1,000 h.p. compound engines of the Corliss type, with 40 dynamos of 250 h.p. each.

THE ELECTRICAL ENGINEER.

[Published every Friday.

Price Threepence ; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices :

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, 139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.

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BOUND VOLUMES.

Vols. I., II., and III., new series, of "THE ELECTRICAL ENGINEER" are now ready, and can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

IMPORTANT NOTICE.

We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No paper that we know ever refuses Subscribers or Advertisers. Nor do we ; in fact, we invite them, believing that they will get full value for their money.

Specimen copies of the paper will be sent on request,

FIRES AND RUMOURS.

It seems a waste of power to be always harping upon one subject, but when that subject is popular ignorance, and the prosperity of an industry depends upon popular enlightenment, time and words spent on the latter are by no means wasted. America seems destined to beat the record in all directions. At present, development electrically is going on there at an exceedingly rapid rate. The latest news is that the biggest fire on record had an electrical origin. The news hardly possesses the stamp of authenticity, and as given in some of the English papers is absolutely untrustworthy. There is a peculiar glamour attaching to the unknown ; if anything happens not directly traceable to a cause, what more easy than to attribute it to the unknown quantity? Electricity is still a myth to the multitude—it is indeed to the few ; but the latter understand somewhat of the phenomena attributable to it, while the former imagine that any and everything may be attributed to it. The *bête noire*, as well as the elixir of life, must certainly be electrical. Ghostly visitants, if such exist, may have an electrical origin. Who can wonder, then, but fires are certain to be classed as of electrical origin if there is a wire about the place? No doubt electricity has its bad points as well as its good ones ; so has steam, so has gas, so have most things. No doubt a bad name has clung around electrical apparatus, more because most of the popular experiments shown to popular audiences are accompanied by "sparks." The lecturer wants to amuse his audience—hence these fireworks. Many, if not most people, retain the idea that electrical phenomena and sparks are synonymous. If you have one, you must have the other—hence they express no surprise that fires are attributed to electricity, but rather the contrary, and feel as if nothing better could be expected. If you will use these dangerous things, what can you expect? These views evidently permeate the minds of those who are understood to constitute the fourth estate of the realm, witness the telegrams and leaderettes and notes that are prominently given in the columns of the newspapers. By one we are gravely informed that a fire is caused by the wires that ramify hither and thither controlling a system of electric clocks. That is all, and every reader of that paper henceforth believes in the excessive danger of wires to electric clocks. What do those who are raised a step above this depth of ignorance say? It would ill become the columns of a staid and sober technical paper to translate their sayings. We are in the position of the man who was celebrated throughout the whole district for his freedom and his familiarity with the language of Billingsgate. One day, however, driving a horse drawing a cart full of turnips uphill, the tail-board fell out, so did the turnips. The onlookers

expected something unique in the way of swearing, but were astonished at the result, for the man said "his vocabulary was utterly inadequate to give expression to his feelings on the occasion." Ditto.

Let those who talk about danger try to make a fire either with telegraph, telephone, or electric clock wires. After they have tried their utmost they will probably jump to the other extreme and say it can't be done. While we should hesitate to make so sweeping an assertion, it is practically certain that the American fires have not had their origin in these directions. We will now go further and introduce the real Simon Pure, the electric light wire. There may be danger in a general tangle of electric light wires with electric clock, telephone, or telegraph wires, but again the glamour of the unknown comes in, and attributes the most improbable things to such a tangle, as it does to the electric light wires alone. What, for example, can we think of the paper that publishes leaderettes upon the complete fusion of the stones in a pathway because something is wrong with the electric light wires underneath, which are carrying a current under a pressure of 110 volts? Fancy a miniature Etna or Hecla underneath the streets when such a fault as this takes place. Volcanic action—the fusing of metals and rocks is not so very wonderful after all if paving stones can be fused so easily. But here, again, the thousands or hundreds of thousands that read the leaderette will imbibe consciously or unconsciously additional respect for the marvellous, as it relates to electricity, and especially hard will it be upon those who have given some attention to the subject to combat the views thus obtained.

Coming back to the point at issue, we accuse these careless writers of unnecessarily alarming the general public, of disseminating fictions which it is almost impossible to eradicate, and so making an immense amount of dislike when there is no occasion for it. There are certain dangers to be avoided, but not in the directions these writers indicate. There may be danger if electric light wires break or come into contact with other wires. A fire caused by an electric clock wire is almost an impossibility, but there might be a fire caused by an electric light wire coming into contact with an electric clock wire. The two statements are entirely different. There can be no objection in stating the truth, because, when it is known, it is seen how easily danger in this case may be avoided. Then as regards the fusing of a stone pavement by a current under a pressure of 110 volts, we believe the thing to be utterly impossible, and we deny it ever happened. Like a good many other things from America, the senders believe any tale good enough to tickle the English public with, and our papers are ready to swallow the concoction sent and give it their imprint.

It is the boast, and a just one, that wherever the

Phoenix rules and regulations have been carried out, and the installation duly supervised, there has been no alarm of fire. We have long contended that with the electric light properly installed, there is infinitely less danger of fire than with any other known artificial illuminant. These are facts easy of proof. We do not find the papers making a fuss and writing leaderettes on accidents from naphtha, paraffin, gas, or tallow, which in numbers are far and away out of all proportion to those by electrical wires of every kind, yet we should imagine that if the American fires could be traced to their source it would be found to be in a direction other than electricity.

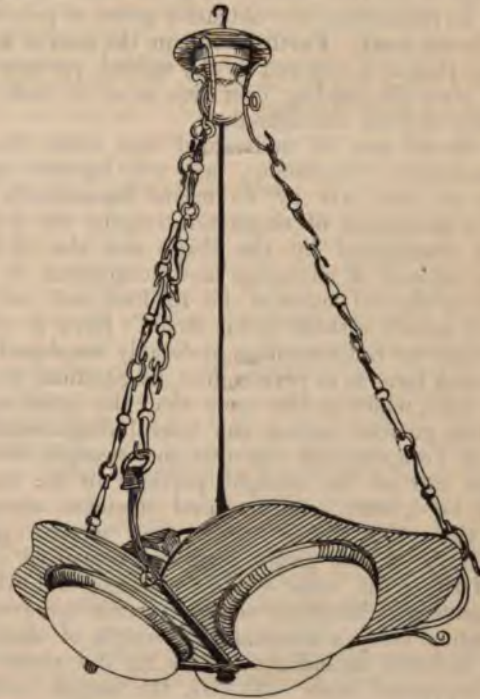
"And therefore, unless you can speak to the point, you must look for a millstone handy and good,

Fresh hewn from the rock, to shiver and shock the unyielding grit of my resolute mood."

as Aristophanes has it.

REFLECTORS.

We herewith illustrate another importation from America, a reflector, introduced by Mr. R. L. B. Rathbone, of Liverpool. It consists of a conical globe of fine flint glass, rounded and frosted at the base, the upper sides being of clear glass, covered by hand with burnished silver in such a way that it will never tarnish or oxidise.



The shade is open at the top to admit of the insertion of the incandescent lamp, which throws its rays into the silvered mirror all around it, and this reflects them into and through the convex base, which, being of frosted glass, so breaks up the rays that although the mass of light proceeding from it is considerably more than twice as powerful and bright as that coming from the lamp ordinarily, it is not only less dazzling, but it is absolutely soft and pleasant to the eyes.

The difference in the light thrown on to the desk or table when the shade is in use has to be seen to be believed. If the shades are fixed at an angle, the light may be projected in any direction required to surprising distances, and in this way they can be arranged in fittings which with quite a few lamps will brilliantly illuminate the largest rooms. This is more especially the case where the larger sizes of shades are used, accommodating lamps of 50, 100, or 150

c.p. By hanging the small shades over office desks and using 8 or 10 c.p. lamps, a far superior light is still obtained at a great economy of electricity as against ordinary fittings with 16 c.p. lamps.

The shades are of great value to all persons engaged in literary or desk work of any kind, as the illumination is particularly soft and brilliant. Gas and electric lamps, without the shade, give a reflection from glazed paper which makes it impossible to see to write on it at certain angles, or to protect the eyes from the reflection of light from the paper up to the eyes, as is the case with all other shades. The new reflector shade absolutely destroys this. In factories, theatres, libraries, reading-rooms, billiard-rooms, etc., it is just what is wanted to make incandescent electric light perfect.

ELECTRICALLY-WELDED RAILS.

In a letter addressed to the *Street Railway Journal*, Prof. Elias E. Ries thus describes his patent system of welding rails by electricity:

"The principal features of this system of plate laying are that instead of employing the usual rail joints with their attendant connections, such as fishplates, bolts, locking devices, etc., the ends of the rails, when in position, are permanently and expeditiously welded together by the passage of a gradually increasing, heating current of electricity through the ends of the rails to be united. In this manner a single, uninterrupted, and perfectly smooth rail of any desired length can be made. In order to further increase the strength of the weld, the cross-section of the rails is somewhat enlarged at these points during the welding process by the formation of a rib between the head and the flange of the rail, where T or girder rails are employed; or at a corresponding non-obtrusive point or points where flat rails are used. Furthermore, in the case of hardened rails the temper is restored to the welded portions immediately after the welding operation so as to make it substantially uniform throughout.

"It should now be understood that while these rails are practically 'continuous,' as will become apparent further on, they are by no means theoretically so. In all cases, the length of single rail lengths for any given road is determined by the shape and size of the rail and the amount of expansion and contraction of 'creep,' that the grade and nature of the roadbed and rail fastenings will permit without undue strain. Here it should be stated that the rail fastenings preferably employed by me are of such form as to permit free longitudinal movement of the rails, while at the same time the latter are most effectively guarded against any lateral displacement. On the New York elevated railroads, for example, the length of each rail on the straight portions of the line could readily be 1,000ft., and on level stretches considerably more than this. For cable and electric railroads, where rails of the girder type are supported at intervals of 4ft. or 5ft. upon conduit castings, and where the street pavement interferes somewhat with the freedom of longitudinal creep, a maximum rail length of about 500ft. would probably be sufficient, while for flat, centre-bearing rails, supported upon stringers, the length could on a good roadbed be considerably increased. Each rail, whatever its length, is rigidly secured, at a point midway between its ends, to the roadbed or conduit structure in such a manner that it can only expand toward or contract from both ends, the centre remaining stationary.

"The coefficient of expansion per unit for steel per 1deg. F. is .0000066. A steel rail 500ft. in length would, therefore, expand or contract .396in. for each 10deg. variation in temperature. Allowing a maximum range of temperature of 150deg. F., we have a total expansion and contraction of 5.94in., or something less than half a foot to provide for in each length of 500ft. Now, inasmuch as each 500ft. length is firmly secured at its centre, the maximum movement at its extremities within the entire range of temperature above stated can never exceed 3in. It must, however, be borne in mind that a change in temperature of 25deg., which is about the usual maximum variation occurring within the limits of a day of 24 hours

in this latitude, can only produce a movement of half an inch at the extremities of each 500ft. rail section, which, of course, is doubled for the 1,000ft. lengths. This small amount of daily creep, assisted as it is by the traffic over the road, is scarcely perceptible, and can be allowed without detriment even in cases where the rails are secured by ordinary spikes.

"It will be apparent that some means are required to compensate for the variations in the rails lengths, and to render the rail surface continuous. This is effected in a very simple manner by means of divided 'expansion joints' of special construction. These comprise a rigid elongated chair provided with a self-cleaning groove to receive and guide the ends of two adjoining rail sections, the extremities of the rails being faced off on opposite sides so as to partially over-lap each other. The arrangement is such as to provide for the maximum variation that can take place and yet leave the rail surface of the entire line continuous and unbroken, so that the passage of a car from one rail section to the next cannot be detected. On curves the rails forming the curve are welded together, and form a section by themselves, the fixed portion being at the centre of the curve, and the expansion joints being located on the straight portion of the track a short distance before and beyond the curve respectively.

"Full provision is also made for removing worn or defective portions of any rail section and replacing the same with a new rail of corresponding length whenever necessary, and this can be readily accomplished without interruption to traffic by means of a special electrical appliance devised for the purpose.

"The rail-welding process is applicable to old and new roads, and time occupied in forming the weld joints is comparatively short. The current required for the purpose of effecting the welds may either be supplied by a local apparatus or taken from any suitable electric light circuit, the wires of which extend along the line of way, the current in the latter case being transformed into a heating current at or near the welding clamps. The cost of construction on new lines is much less than the cost of the fishplates, bolts, nuts, washers, etc., that are dispensed with by it, and the strength of the welded joints is many times greater than that of the joints now in use. When applied to new conduit lines, whether electric or cable, the brackets or yokes are preferably formed with a grooved support, permitting free longitudinal movement of the track rails. In the case of electric railroads, the conduit or overhead electric conductors are likewise welded electrically by the same process."

INSTITUTION OF ELECTRICAL ENGINEERS.

The following is the balloting list for council and officers for the year 1890. The ballot will take place on Thursday, December 12, 1889.

President.—J. Hopkinson, M.A., D.Sc., F.R.S.

Vice-Presidents.—William Crookes, F.R.S., Prof. W. E. Ayrton, F.R.S., Alexander Siemens, R. E. Crompton, M.I.C.E.

Ordinary Members of Council.—Major Philip Cardew, R.E., W. Lant Carpenter, B.A., B.Sc., Sir James Douglass, F.R.S., Sir Douglas Galton, K.C.B., D.C.L., LL.D., F.R.S., Gisbert Kapp, A.M.I.C.E., Prof. John Perry, M.E., D.Sc., F.R.S., Sir David Salomons, Bart., M.A., Prof. Silvanus P. Thompson, B.A., D.Sc., F.R.A.S. (remaining on council), Sir James Anderson, Sir Albert J. Leppoc Cappel, K.C.I.E., Sir Henry C. Mance, C.I.E., M.I.C.E., Colonel R. Raynsford Jackson.

Associate-Members of Council.—Recommended by Council: Augustus Eden, Sidney Sharp, Francis H. Nalder.

From this list it will be seen that, naturally, Dr. Hopkinson becomes president, while Mr. Crompton ranks among the vice-presidents. Most attention is generally directed to the new members of council. Of these, Sir James Anderson is probably the best representative of the cable interests that could be found, Sir J. Cappel will represent the Indian members of the Institution, Sir H. Mance the Indo-European section of telegraphs, and Colonel Jackson the telephonic interests. Of the associate-members, Mr. Eden represents postal telegraphy, and Messrs. Sharp and Nalder the newer industries. The remaining officers are as heretofore, except that Mr. Stroh becomes one of the honorary auditors.

ELECTRICAL ENGINEERING IN AMERICA.*

BY G. L. ADDENBROOKE, ASSOCIATE.

The last 18 months or two years in America have been much more characterised by commercial and industrial progress with already existing types of plant and apparatus, than by a number of new inventions. Inventive ability seems to have been more concentrated on improving and elaborating already existing inventions than on the evolution of new forms and ideas.

The leading types of machines and apparatus are all well known to you, and have been so fully described and illustrated that to enter into a minute account of them now would only be to traverse old ground. I therefore propose to devote myself this evening to central station, construction, and internal work, and the application of electricity to tramway and other industrial purposes. Finally, I propose to make a few remarks on the tone, policy, and aims of American electrical engineers, and those commercially interested with them in advancing the application of electricity.

My visit to America was not quite of the ordinary character, as I came through on my way from Australia, and consequently had to traverse the whole breadth of the continent before reaching the better known towns on the Eastern Coast. I was thus able to make a general, if rapid, survey of what is going on in the far West and in towns remote from the manufacturing and engineering centres, as well as in New York and some of the larger cities.

OVERHEAD WORK.

Throughout the continent, from shore to shore, the main thing that forces itself on the observer is the prevalence of arc lighting. Hardly any what we should call moderate-sized village outside the oil region appears to be without its arc lamps.

Arc lamps, when used for public lighting, are usually fixed on poles from 20 to 40 ft. high, according to the caprice of the parties interested in their erection; or they are slung from the corners of intersecting streets, in which case they usually hang low down; or the tower system is adopted. When posts are used, they are of rough pine, never painted, often out of the straight, and warped or bent. If the lamps are fixed, iron spikes are usually driven at intervals on each side of the pole, starting about 8 ft. from the ground, and forming a sort of ladder by which to reach the lamp. During my whole journey from San Francisco to New York, I can hardly recollect seeing one ship-shape, neat, and smart-looking post, whether for carrying arc lamps, or for any other electrical purpose. Everything has a temporary and expedient look about it, which is very offensive to English eyes. Creosoting does not seem to be practised, and the only protection applied to the poles which I saw anywhere consisted of boards fixed round the base, and reaching about 6 ft. high; but this protection was, I think, only applied to large poles carrying circuits or telephone wires.

The lamps themselves are always entirely without ornamentation, and are usually very roughly fixed on the poles. If the globes are not clear glass they are usually only lightly frosted, so that the light glares in one's eyes in all its nakedness.

When the lamps are hung over the centre of intersecting streets, four wires are brought down from the corners of the neighbouring houses, the lamp hangs from the centre, and is lowered and raised by a pulley and cord. The wires from which the lamp hangs, the cord, and the leads all festoon about in accordance with the chapter of accidents, and look, as we should think, both slipshod and untidy.

The only relief to this state of things is afforded by the towers. These towers are usually erected at the intersection of streets, with the four legs at the four angles of the pavement. They are constructed of exceedingly light ironwork. Tapering gracefully upwards to a great height, they are at any rate neat and not uninteresting-looking objects in themselves, and certainly form very definite landmarks. Three or four arc lamps hung round the top of one of these towers shed a sufficient light over a great area where the houses are not high. With this method

of distribution a 20-light machine can be employed to great effect, especially as in country towns and villages, where these towers are chiefly employed, the object is rather to make darkness generally visible, if I may so express it, than to provide bright illumination in well-defined places.

By using the tower method one's eyes are not dazzled by the brightness of the light, which is so much the case with lamps at a low level.

In my own case I used sometimes at night to get quite an irritated feeling when walking about, if at all tired, from the incessant glaring in one's eyes of naked arc lamps, and the impossibility of finding rest anywhere. I mentioned this effect to two or three Americans, but they did not seem to notice it.

Important, however, as the public lighting is, in the large towns it occupies a comparatively inconspicuous place in comparison with the numbers of lights used for illuminating stores, saloons, hotels, restaurants, and all sorts of public buildings. Arc lamps are so lavishly used in these places, both inside and out, that the principal streets are often literally a blaze of light. There were, as far as I could ascertain, about 2,000 arc lamps in nightly use in San Francisco, 3,000 in Chicago, and I understand that 3,500 were shut down in New York while I was there, owing to the accidents which had taken place, and of which so many accounts have been published.

The majority of the arc lamps used outside are fixed by means of light iron rods projecting from the buildings, though some, of course, are hung.

The circuits feeding lamps hung either inside or outside of a building either run direct from the nearest poles on each side of it, thus making an angle over and across the pavement which is very unsightly, or a sort of barrel-shaped glass insulator is used. This insulator has a hole through the centre, and a groove round the middle of the outside. The wire coming in one direction is passed through the centre of the insulator, turned back on itself, and made off. The wire in the other direction is passed round the outside, and also made off on itself. The two ends of the loop are then carried to the lamp, through which the circuit is completed. Nearly all the wire I saw was insulated with "underwriters' insulation." Where lamps are used internally, this is often carried through wooden window frames and such other like places without any further protection or care. Once inside, the wire is carried along ceilings and walls quite exposed, but separated about 3 in. by small wooden cleats. Sometimes instead of cleats small white porcelain insulators are used.

As far as I could learn, it is the invariable custom for all companies to run, fix up, and entirely look after the lamps they operate. The customer simply pays a rent for the use of the lighted lamp of so much a week, month, or year, as the case may be, and has no further trouble of any sort. The rates differ according to the time the lamps are to be in use each night. To see that the lamps burn properly, linemen promenade the streets all night, and are supposed to see every lamp on their circuits at certain intervals.

The circuits themselves are almost invariably carried on poles erected along the edge of the kerbstones. A fair estimate of the average height of these posts is, I think, about 30 ft.; of course some are much more, and many less. Long wooden cross-arms are fixed near the top of the poles, carrying from two to six, and even eight, insulators on each arm. These arms are not so strong as we should make them for the purpose. Owing to the length of the arms, and to their not being very securely fixed to the poles, the weight of the circuits often pulls them out of the horizontal. To see a warped and bent pole, set crookedly in the ground, and with the arms at various angles with each other, and the wires on it all hanging in different curves, seems about as dismal and woe-begone a piece of engineering as can well be imagined.

I must make some exception, however, in the case of the Thomson-Houston Company in New York, who, at any rate, had got light iron stays attached to the poles and arms, at an angle so as to give more support to the arms and keep them in their places.

The insulators are supported on the arms by wooden pegs, which have a screw-thread cut on the part that projects. On this one of the ordinary green glass insulators is

* Paper read before the Institution of Electrical Engineers.

c.p. By hanging the small shades over office desks and using 8 or 10 c.p. lamps, a far superior light is still obtained at a great economy of electricity as against ordinary fittings with 16 c.p. lamps.

The shades are of great value to all persons engaged in literary or desk work of any kind, as the illumination is particularly soft and brilliant. Gas and electric lamps, without the shade, give a reflection from glazed paper which makes it impossible to see to write on it at certain angles, or to protect the eyes from the reflection of light from the paper up to the eyes, as is the case with all other shades. The new reflector shade absolutely destroys this. In factories, theatres, libraries, reading-rooms, billiard-rooms, etc., it is just what is wanted to make incandescent electric light perfect.

ELECTRICALLY-WELDED RAILS.

In a letter addressed to the *Street Railway Journal*, Prof. Elias E. Ries thus describes his patent system of welding rails by electricity:

"The principal features of this system of plate laying are that instead of employing the usual rail joints with their attendant connections, such as fishplates, bolts, locking devices, etc., the ends of the rails, when in position, are permanently and expeditiously welded together by the passage of a gradually increasing, heating current of electricity through the ends of the rails to be united. In this manner a single, uninterrupted, and perfectly smooth rail is produced. The system has just said about short spans for electric light work also applies to telephone and telegraphic work. The spans used in this work are generally also short. In the latter case, since the wires are light, they are run pretty taut without putting much strain on the arms, so that there is not much sag. Wires run in this way are, of course, not so liable to sway about as long spans are in high winds, and make intermittent contact or get overlapped. Further, the wires, being run along the streets, are protected from high winds in a great measure, and are not particularly exposed to them, as our over-house work is. This method of erection, therefore, rough as it is, and notwithstanding the enormous number of wires which are often suspended from one pole, gives an immunity from contacts and accidents that an English engineer at first can hardly understand or appreciate.

For leading in wires into houses, or for putting on extra wires on a pole—in fact, for general purposes of the sort—a block of wood is used, the lower end of which is cut off at an acute angle, the upper being cut away and turned down, and a screw-thread cut on it to carry an insulator. When the face of the angle is fixed against the side of a house or a pole, and a spike or screw put through it, the insulator projects somewhat, and forms a support for making off the wire. The whole thing is of the cheapest description, but, nevertheless, seems to answer its purpose.

Wires are led in from the outside with much less care than is generally used in England; and this applies also to telephone and telegraph work. It often puzzled me how they worked at all after they had been put up a few months. But the fact that the climate is much drier, and fine rain not so frequent as here, has, no doubt, a great deal to do with it. In the case of arc light circuits entering and coming out of houses, and worked in series—as they always are—it is, of course, a material point that although the difference of potential between the circuit and the earth may be 3,000 volts, yet the difference between the outgoing and incoming wire is only some 50 volts; so that the tendency of the current to break across the leads is really small. Again, the chance of the current going to earth on dry ceilings and walls is, when one comes to look into it, not great. Thus, notwithstanding the rough character of most American work, and the poor insulation of the wires, in this class of work there is a greater freedom from faults and a higher margin of safety than one would at first imagine. The only place where the margin of safety is really low is where the wires enter buildings.

I have now, I think, gone over all the main points in arc lighting construction work. Construction work for alternating currents is generally carried out on much the same

in this latitude, can only produce a movement of half an inch at the extremities of each 500ft. rail section, which, of course, is doubled for the 1,000ft. lengths. This small amount of daily creep, assisted as it is by the traffic over the road, is scarcely perceptible, and can be allowed without detriment even in cases where the rails are secured by ordinary spikes.

"It will be apparent that some means are required to compensate for the variations in the rails lengths, and to render the rail surface continuous. This is effected in a very simple manner by means of divided 'expansion joints' of special construction. These comprise a rigid elongated chair provided with a self-cleaning groove to receive and guide the ends of two adjoining rail sections, the extremities of the rails being faced off on opposite sides so as to partially over-lap each other. The arrangement is such as to provide for the maximum variation that can take place and yet leave the rail surface of the entire line continuous and unbroken, so that the passage of a car from one rail section to the next cannot be detected. On curves the rails forming the curve are welded together, and form a section by themselves, the fixed portion being at the centre of the curve, and the expansion joints being located on the straight portion of the track a short distance before and beyond the curve respectively.

"Full provision is also made for removing worn or defective portions of any rail section and replacing the same with a new rail of corresponding length whenever necessary, and this can be readily accomplished without case the poles in the side streets are generally smaller. It is surprising the length some of the arc circuits extend in this way, not unfrequently over a dozen miles.

As all the machines in a station are usually of the same size, and are run at the same speed, when the circuit is long the number of lamps fed off a nominal 60-light machine may perhaps have to be reduced to 45 to allow for the resistance of the leads. As you are aware, some of these arc machines are now used on power circuits in the daytime, which forms a very welcome source of extra revenue.

I trust I have not wearied you by a too minute description of this, a not very interesting part of electrical engineering in America; but I was anxious to convey as clearly as I could on what a remarkably simple and crude basis almost the whole fabric of American electrical engineering in this particular at present rests. For I think I am not overstating facts in saying that at least nine-tenths of all the electrical work in America—putting aside isolated plants—is carried out, as far as the construction work is concerned, in the manner I have described. In all this portion of the work I saw next to nothing which showed particular ingenuity, skill, or brilliancy of idea. Simple and crude means were everywhere used to effect in a rough and crude manner the end desired. In the means employed there is little to excite either admiration or interest. The interest lies in the fact that in such a simple and elementary manner so much has been done.

UNDERGROUND WORK.

Turning now from this branch of the subject to underground work, I must confess that I had a good deal of difficulty in getting really accurate and reliable information on this subject—at any rate, of a comparative character. The Edison Company have, of course, buried their wires all along, and their three conductors enclosed in an iron tube, run solid, with insulating material inside, are well known. As far as I could ascertain, the various systems of conduits have not proved very successful so far, and, since the proof of the pudding is in the eating, the fact that the Subway Company in New York are, I believe, laying down iron pipes entirely—at least, they were in every place I saw work going on—points to this conclusion.

The system of construction for underground work at present being carried out in New York is as follows: Manholes at convenient distances are made in the roadway—not, as a rule, in the pavement, but just on the rise of the road, and clear of the gutter. These manholes are circular, and are covered by a heavy iron lid. Below the manhole is a bell-shaped pit, 8ft. or 9ft. deep, and bricked round, and of sufficient size at the bottom for a couple of men to stand fairly comfortably to work. Iron pipes, such as are

ELECTRICAL ENGINEERING IN AMERICA.*

BY G. L. ADDENBROOKE, ASSOCIATE.

The last 18 months or two years in America have been much more characterised by commercial and industrial progress with already existing types of plant and apparatus, than by a number of new inventions. Inventive ability seems to have been more concentrated on improving and elaborating already existing inventions than on the evolution of new forms and ideas.

The leading types of machines and apparatus are all well known to you, and have been so fully described and illustrated that to enter into a minute account of them now would only be to traverse old ground. I therefore propose to devote myself this evening to central station, construction, and internal work, and the application of electricity to tramway and other industrial purposes. Finally, I propose to make a few remarks on the tone, policy, and aims of American electrical engineers, and those commercially interested with them in advancing the application of electricity.

My visit to America was not quite of the ordinary character, as I came through on my way from Australia, and consequently had to traverse the whole breadth of the continent before reaching the better known towns on the Eastern Coast. I was thus able to make a general, if rapid, survey of what is going on in the far West and in towns remote from the manufacturing and engineering centres, as well as in New York and some of the larger cities.

Insulating material is covered with a thick, and containing, I believe, a percentage of tin. These lead-covered cables are usually jointed at each manhole, and a little slack left on them there. The jointing is done by a special system, and when it is complete electrically the two lead tubes are drawn together over a small bit of brass tube, which protects the point of junction. They are then "wiped" together with a hot iron like an ordinary plumber's joint. No doubt this work is heavy and expensive, but it looks as if it should last when once put down.

INTERNAL WORK.

Coming, now, for a moment to the internal work in buildings, most of what I saw had a rough, temporary look about it, evidently being put up as cheaply as possible. I do not say that no good, solid work is done, but the proportion of it to the remainder is, I fancy, a good deal smaller than in this country.

Gas-fittings are freely utilised, and I think I am correct in stating that in the arrangement of lights the gas-fitting way of managing things is adhered to much more closely than in this country, where we have rather tried to avoid imitating the ordinary ways of arranging gas lights.

Turning aside for a moment, it appears to me that one of the great wants all over the world now is, if I may so term it, a "science of illumination." Up to and as far as providing light we are exceedingly scientific. But in utilising it when we have got it, we proceed in an elementary and haphazard manner.

Mr. Preece has, I know, from the first paid a great deal of attention to this point, and appreciated its value. It seems to me that it would really be of great practical benefit if a committee of this Institution, or some other responsible body, would accumulate some accurate and authoritative data on the subject. When once started properly these data would increase of themselves, and would soon form a guide which would be exceedingly useful in drawing up specifications and arranging to the best advantage the lighting of either open spaces, public buildings, or private houses.

We all have our own indefinite notions on the subject as the result of experience, but if they could only be put into definite shape—and I think the subject does admit of being put into definite shape—it would, I feel sure, be a great advantage.

Of course there are innumerable patterns of switches and cut-outs and fittings in America, as here, but none came to my notice showing any very brilliant conception in design. Lamp sockets and fittings are generally somewhat larger and clumsier than with us.

The chief difference I noticed was that a switch is almost

of distribution a 20-light machine can be employed to great effect, especially as in country towns and villages, where these towers are chiefly employed, the object is rather to make darkness generally visible, if I may so express it, than to provide bright illumination in well-defined places.

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In my own case I used sometimes at night to get quite an irritated feeling when walking about, if at all tired, from the incessant glaring in one's eyes of naked arc lamps, and the impossibility of finding rest anywhere. I mentioned this effect to two or three Americans, but they did not seem to notice it.

Important, however, as the public lighting is, in the large towns it occupies a comparatively inconspicuous place in comparison with the numbers of lights used for illuminating stores, saloons, hotels, restaurants, and all sorts of public buildings. Arc lamps are so lavishly used in these places, both inside and out, that the principal streets are often literally a blaze of light. There were, as far as I could ascertain, about 2,000 arc lamps in nightly use in San Francisco, 3,000 in Chicago, and I understand that 3,500 were shut down in New York while I was there, owing to the accidents which had taken place, and of which so many accounts have been published.

The majority of the arc lamps used outside are fixed by means of light iron rods projecting from the buildings, though some, of course, are hung.

The circuits feeding lamps hung either inside or outside placing the engines and switchboards on the highest poles on arranging the dynamos, switchboards, and electrical portion of the station on the first floor. In this instance the second floor is used as a storehouse, and for general purposes.

The boiler-house forms one end of the building, and there was nothing above it. It is arranged for two lines of boilers, one on each side, one side only being filled up at present. They face towards the centre of the building, with a large space between for coal and general working purposes. The boilers were of the well-known water tube pattern. This type, varied slightly in detail by each maker, seems to be in general use everywhere in the States. From the boilers the steam is led to a 650 h.p. single-cylinder Corliss engine, which, by rope gearing, drives a single line of countershafting. I must say I was surprised to find that, in a new station so large as this, and one in which expense evidently had not been spared, the engine was neither compound nor condensing, particularly as there was water within a moderate distance. There was only this one engine in the station driving all the dynamos, though space was provided for three more as the amount of lighting increased. The working of the station was therefore dependent on the single engine and line of shafting keeping in good order. The engine drove this line of countershafting as I have said, the loose pulleys being on the shafting. At the stations I visited where countershafting was in use I was struck with the care and completeness with which means were provided for adjusting the plumber blocks and bearings in any direction. The general idea was somewhat as follows: The plumber block, or upright, stood in a cast-iron shoe with a flat planed bottom, through which the holding-down bolts projected. The holes for the holding-down bolts in the plumber block were bored large so as to permit a certain movement in the block. The edges of the cast-iron shoe were turned up all round, and through these edges projected screw bolts, the points of which touched the plumber block. By loosening, then, the holding-down bolts at any time, and screwing or unscrewing the screw bolts as required, the block could be slewed slightly or adjusted to line with the greatest nicety and ease. Besides this, the under bearing worked in guides, being kept in its place by a strong screw projecting up from underneath. By working on this screw, and on the cap of the upper bearing, the height of the bearing could, of course, be adjusted with great exactness. With these means the brasses are also quickly and easily replaced; while if they get warm when the shaft is running, the bottom bearing can be slacked down. The Thomson-Houston Company in New York told me they

screwed. Green glass insulators are used for every purpose in America, whether for electric light, telegraphs, or telephones. They are very cheap, and answer the purpose well. Still, the effect of green glass insulators on arms painted a dull red, fixed on bare poles from which the bark has just been stripped, is not æsthetic.

The majority of the poles for circuits have no steps provided for ascending them. On the frequent occasions when it is necessary to go up to the top to make alterations or add new circuits, the linemen use climbing irons. The tearing of the wood by the spikes of these climbing irons gives the poles a jagged and frayed-out appearance from top to bottom. One could fancy they lead to the habitation of some immense squirrel.

The Americans nearly always use solid wire for running their circuits, covered, as I have mentioned already, with underwriters' insulation. Little trouble is taken to keep the various circuits on one pole in regulation with each other, as long as they do not touch. Indeed, the whole construction of the poles and arms is so flimsy that no great strain could be put on the wires. The poles themselves are fixed at short intervals, often not more than 30 yards apart, and seldom above 60.

The circuits are rather hung up on the poles than run, in the sense an English lineman attaches to the word. Separate suspenders I never saw used, except for telephone cables. For alternating incandescent circuits of 1,000 volts, several separate cables of small size are also used, instead of running a large one with suspenders, as has been the custom here.

What I have just said about short spans for electric light work also applies to telephone and telegraphic work. The spans used in this work are generally also short. In the latter case, since the wires are light, they are run pretty taut without putting much strain on the arms, so that there is not much sag. Wires run in this way are, of course, not so liable to sway about as long spans are in high winds, and make intermittent contact or get overlapped. Further, the wires, being run along the streets, are protected from high winds in a great measure, and are not particularly exposed to them, as our over-house work is. This method of erection, therefore, rough as it is, and notwithstanding the enormous number of wires which are often suspended from one pole, gives an immunity from contacts and accidents that an English engineer at first can hardly understand or appreciate.

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Wires are led in from the outside with much less care than is generally used in England; and this applies also to telephone and telegraph work. It often puzzled me how they worked at all after they had been put up a few months. But the fact that the climate is much drier, and fine rain not so frequent as here, has, no doubt, a great deal to do with it. In the case of arc light circuits entering and coming out of houses, and worked in series—as they always are—it is, of course, a material point that although the difference of potential between the circuit and the earth may be 3,000 volts, yet the difference between the outgoing and incoming wire is only some 50 volts; so that the tendency of the current to break across the leads is really small. Again, the chance of the current going to earth on dry ceilings and walls is, when one comes to look into it, not great. Thus, notwithstanding the rough character of most American work, and the poor insulation of the wires, in this class of work there is a greater freedom from faults and a higher margin of safety than one would at first imagine. The only place where the margin of safety is really low is where the wires enter buildings.

I have now, I think, gone over all the main points in arc lighting construction work. Construction work for alternating currents is generally carried out on much the same

lines as for arc lighting; the only difference is that in the latter case converters are struck against the outside of buildings instead of arc lamps, which, of course, are in parallel instead of in series. A rough hole is knocked through the brickwork just under the place where the converter is fixed, for the secondary leads, which are slipped through a couple of rubber tubes and carried inside. But little attempt is usually made to execute this part of the work in what we should call a neat or workmanlike manner.

Let us now make a *resumé* of this branch of the subject. There are in America now, I believe, more than a quarter of a million arc lamps in constant use. In the large towns these arc lamps are fed by machines equal to keeping going 50 or 60 lamps each.

Outside a central station, supposing it to be for 1,000 lights, we shall find tall and untidy-looking poles 30ft. or 40ft. high. At the top these poles will have four or five cross-arms, each carrying six or eight insulators. These poles will be continued along the neighbouring streets at intervals of 30 yards to 60 yards, according to circumstances. Every here and there a circuit will leave the rest for the side of a neighbouring house, supply one or more lamps, being run in the latter case along the face of the houses, and then return again at the next pole. Or a circuit may jump across the street, supply a lamp or two, and then return again to the nearest pole on the side it first started from.

Here and there one or two circuits will leave the main line of poles altogether, and turn up a side street. In this case the poles in the side streets are generally smaller. It is surprising the length some of the arc circuits extend in this way, not unfrequently over a dozen miles.

As all the machines in a station are usually of the same size, and are run at the same speed, when the circuit is long the number of lamps fed off a nominal 60-light machine may perhaps have to be reduced to 45 to allow for the resistance of the leads. As you are aware, some of these arc machines are now used on power circuits in the daytime, which forms a very welcome source of extra revenue.

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UNDERGROUND WORK.

Turning now from this branch of the subject to underground work, I must confess that I had a good deal of difficulty in getting really accurate and reliable information on this subject—at any rate, of a comparative character. The Edison Company have, of course, buried their wires all along, and their three conductors enclosed in an iron tube, run solid, with insulating material inside, are well known. As far as I could ascertain, the various systems of conduits have not proved very successful so far, and, since the proof of the pudding is in the eating, the fact that the Subway Company in New York are, I believe, laying down iron pipes entirely—at least, they were in every place I saw work going on—points to this conclusion.

The system of construction for underground work at present being carried out in New York is as follows: Manholes at convenient distances are made in the roadway—not, as a rule, in the pavement, but just on the rise of the road, and clear of the gutter. These manholes are circular, and are covered by a heavy iron lid. Below the manhole is a bell-shaped pit, 8ft. or 9ft. deep, and bricked round, and of sufficient size at the bottom for a couple of men to stand fairly comfortably to work. Iron pipes, such as are

used for water or gas, are laid in the ground from one man-hole to the next. I understand that each electric company will, as a rule, have a separate pipe, so that if there are several companies running along the street, they will each require a separate line of piping opening into the manhole. There will, therefore, often be several pipes entering at each side of the manhole. These pipes enter the manhole at such a height as, roughly, to come between the hips and breast of a man standing on the bottom—at a height, in fact, to bring them in a fairly convenient position for working. The cables are drawn through the iron pipes in the ordinary way. Branches are taken from the manholes under the roadway and pavement to any house between the manholes requiring current.

As regards the class of cable which is being largely laid down in these conduits, the conductor consists of seven strands of No. 16 copper. These are insulated by a layer of a hard but somewhat flexible material, containing, I believe, some rubber in conjunction with other materials, but the complete material is cheaper than rubber used alone. The thickness of this material surrounding the conductors is $\frac{1}{12}$ th of an inch. It somewhat resembles ebonite, and is of a consistency to stand rough usage and hard wear. It will be interesting to see how it lasts in practice. I must say it seems to me a very suitable material for the purpose for which it is intended, and, as far as insulating qualities go, I was able to see the record of tests of a good deal that has been laid, and they were excellent, going up to several thousands of megohms per mile. The insulating material is covered with a lead pipe about $\frac{1}{16}$ in. thick, and containing, I believe, a percentage of tin. These lead-covered cables are usually jointed at each manhole, and a little slack left on them there. The jointing is done by a special system, and when it is complete electrically the two lead tubes are drawn together over a small bit of brass tube, which protects the point of junction. They are then "wiped" together with a hot iron like an ordinary plumber's joint. No doubt this work is heavy and expensive, but it looks as if it should last when once put down.

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The chief difference I noticed was that a switch is almost

invariably included in each lamp-socket. Americans, as a rule, do not go to the same amount of trouble and expense that is general here to fix switches in handy places near doors. If you want the light on or off, you turn it on or off at the burner as you would do gas.

CENTRAL STATIONS.

Coming now to central stations, those I went over were the new arc light station in San Francisco, the Edison station in Chicago, the Westinghouse station in Pittsburg, and the Thomson-Houston station in New York; and I may add that since my return to London I have had an opportunity of going carefully over the new Westinghouse station in Sardinia-street, Lincoln's-inn-fields, the plant in which is entirely of American manufacture and pattern, and arranged in the American manner.

I might easily have seen many more stations, in some cases perhaps larger and better arranged than those I did see. But those I did see are, I think, all typical of the latest American work, and all were in the process of making large additions to their plant, so that they were quite up to date.

The station in San Francisco is near the railway station. It is a large brick building, erected entirely for its present purpose, about 250ft. long by 80ft. broad, with a ground and two upper floors, and has been finished about eight months. It is intended to provide accommodation for about 2,000 arc lights when filled up. At present it is furnishing current for about 600. It is arranged in the usual—I was going to say invariable—American plan of placing the engines and boilers on the ground floor, and arranging the dynamos, switchboards, and electrical portion of the station on the first floor. In this instance the second floor is used as a storehouse, and for general purposes.

The boiler-house forms one end of the building, and there was nothing above it. It is arranged for two lines of boilers, one on each side, one side only being filled up at present. They face towards the centre of the building, with a large space between for coal and general working purposes. The boilers were of the well-known water tube pattern. This type, varied slightly in detail by each maker, seems to be in general use everywhere in the States. From the boilers the steam is led to a 650 h.p. single-cylinder Corliss engine, which, by rope gearing, drives a single line of countershafting. I must say I was surprised to find that, in a new station so large as this, and one in which expense evidently had not been spared, the engine was neither compound nor condensing, particularly as there was water within a moderate distance. There was only this one engine in the station driving all the dynamos, though space was provided for three more as the amount of lighting increased. The working of the station was therefore dependent on the single engine and line of shafting keeping in good order. The engine drove this line of countershafting as I have said, the loose pulleys being on the shafting. At the stations I visited where countershafting was in use I was struck with the care and completeness with which means were provided for adjusting the plummer blocks and bearings in any direction. The general idea was somewhat as follows: The plummer block, or upright, stood in a cast-iron shoe with a flat planed bottom, through which the holding-down bolts projected. The holes for the holding-down bolts in the plummer block were bored large so as to permit a certain movement in the block. The edges of the cast-iron shoe were turned up all round, and through these edges projected screw bolts, the points of which touched the plummer block. By loosening, then, the holding-down bolts at any time, and screwing or unscrewing the screw bolts as required, the block could be slewed slightly or adjusted to line with the greatest nicety and ease. Besides this, the under bearing worked in guides, being kept in its place by a strong screw projecting up from underneath. By working on this screw, and on the cap of the upper bearing, the height of the bearing could, of course, be adjusted with great exactness. With these means the brasses are also quickly and easily replaced; while if they get warm when the shaft is running, the bottom bearing can be slacked down. The Thomson-Houston Company in New York told me they

did this, and their dynamos are on the same floor as the line of shafting. It is, of course, a still simpler and safer matter to do this when the dynamos are situated almost right above the shafting, as is the general practice in American stations. Leather belting of the ordinary description was in use, except for driving, where ropes are used, as I have mentioned. I found leather belting employed at each of the stations I visited.

These long lines of countershafting must, of course, be wasteful of power; still, it is worth pointing out that such shafting runs under the best conditions when doing work right overhead, since both the dead strain and the running strain on the belts to the dynamos tend to lift the line of countershafting, which, therefore, if the weight is properly adjusted, must run very lightly in its bearings.

The method of driving from underneath is also economical in belting, since the weight of the belt hanging on the dynamo pulley causes it to have a good grip, and permits of a short length being used. The belts pass up to the dynamos through holes in the floor, the holes being elongated to permit the belt being tightened, if necessary, by screwing the dynamo along on its bed rails.

In each of the stations I visited in America the upper floor carrying the dynamos was entirely of wood, strongly made, and supported from underneath at intervals by stout wooden uprights, but still of wood.

The weight of the floor in the San Francisco station is entirely supported by the wooden uprights, being only steadied at the sides. I was informed that at the old station in San Francisco, worked by same company, and which, I understood, was supplying about 1,200 arc lights, a good deal of trouble was experienced from the floor, which was fixed to the walls, and which, vibrating with the motion of the machinery, shook the brickwork. I found the vibration on these wooden floors less than I anticipated, considering the amount of machinery on them; but, of course, the motion of a good dynamo is very even, and if the joints on the belt are neatly made there is no jerking.

In this San Francisco station all the machines were Brush 60-lighters. From 50 to 60 lights in series on one circuit seems to be about the general rule for lighting in America when any number of lights is required. As all the machines are run from the same countershafting, and at the same speed, whatever work they may be doing, it is necessary to provide an automatic regulator to adjust the current through the field-magnets for each machine when doing less than its normal output. On the other hand, if the circuit is a very long one—and I was told some of the circuits at San Francisco are as much as 13 or 14 miles—the number of lamps on the circuit must be reduced to compensate for the extra resistance. These Brush dynamos were all mounted on short iron columns about 9 in. high, so that they were lifted entirely from the floor. I was told that this arrangement was found very handy for keeping the machines clear and free from dirt, and for inspecting them. I did not notice much difference between the machines and those turned out by our friends on this side of the water, and the style of the workmanship seemed to be about the same. A light overhead trolley, with lifting gear, ran overhead so that it could quickly be brought over any machine, and I was informed that should a machine go wrong they could replace an armature in half an hour. In the older station in San Francisco a large number of Thomson-Houston machines are used, but Brush machines only are employed in the new station, as they find the Brush armature is more easily replaced, and is so much the easier of the two to repair if anything goes wrong. It is worthy of note in this connection that the latest advices from America inform us that the Thomson-Houston Company have bought the Brush Works at Cleveland, Ohio, and, therefore, presumably the Thomson-Houston Company will in the future control this interest as well as their own.

From the dynamos the mains are led to a long, narrow shelf, where are fixed the resistances and indicating instruments for each machine. The mains next proceed to the switchboard, which is of the plug pattern—brass plugs, with boxwood handles, united by a flexible insulated cord. All the flooring being of wood, as it is in each of the stations I saw, and being kept clean and dry, the risk of getting a bad shock is not great, except by shunting the

current through oneself, or getting in series with a main, which are not ordinary accidents.

At San Francisco the motor business is steadily increasing, and forms a welcome addition to the revenue of the station without a very great additional expenditure.

I will now go on to the Edison station in Chicago. There is no necessity to describe it at length, as the plans on which Edison stations are constructed have been published over and over again.

The boilers, which are situated on the ground floor, are of the water-tube pattern—Heine arrangement. In this pattern, which seems to be a good deal used, the tubes are much more nearly horizontal than in the well-known Babcock and Wilcox type. All the tubes come into a large flat box at each end, and there are small manholes in the boxes opposite the ends of the tubes, for getting at them. These flat boxes are prevented from expanding with the pressure by tabular stays, which pass right through them, and are expanded in their places. These small tubes serve as blowholes for directing a jet of steam on the upper side of the tubes to clear them of ashes. They are kept plugged up with a stopper, under ordinary circumstances, to prevent the gases coming through. These boilers had a damper projecting downwards in the furnace opening for directing the draught over the surface of the coal when firing, to cause more complete combustion and prevent smoke. This damper may have been of some use for the purpose, but it certainly made it a difficult operation to fire properly.

The engines were also in the basement, in the next room to the boilers. They were of the ordinary Armington-Sims pattern, single cylinder, and neither compound nor condensing. There was one to each dynamo, the dynamos being situated overhead on the floor above. The dynamos were of the ordinary Edison pattern for, I think, 1,500 lights each. Everything was very neatly arranged in the dynamo-room, the current being conveyed about by large copper bars. The walls were simply lined with resistances and indicators for the different circuits. In fact, the place gave one rather the impression of a wholesale clock store, though the attendant informed me they did not have much difficulty in keeping their resistances properly adjusted. All the mains are underground, on the three-wire system. Indeed, there is a good deal of underground work in Chicago, the Telephone Company also having a large number of cables buried.

The next station I visited was that of the Westinghouse Company, at Pittsburg. It is situated in a large building of the warehouse type, quite in the centre of the town.

The boilers here are of the water-tube type, but heated by natural gas instead of coal. This natural gas is brought in pipes to the town from a distance of 35 miles. The company who own the line of piping—of which, by the way, Mr. George Westinghouse is also president—sell this gas to manufactories, etc., at a rate which is nearly equivalent to the cost of coal, so that, although the convenience is great in using it, the economy is not so large as might at first be anticipated.

Work at the Pittsburg station was in the first instance begun with two Corliss single-cylinder engines of the ordinary type, driving on to a line of countershafting; but this method of working has not been extended, and one of these engines has since been removed. The next additions to the station consisted of Westinghouse standard engines of 250 i.h.p., driving 2,500-light alternating dynamos. These engines stand on square blocks of concrete and masonry; the blocks for this sized engine are about 7 ft. by 5 ft. The last additions are of the new type of Westinghouse compound engine. From a power point of view, as well as from electric lighting point of view, the station has therefore something of historical interest.

While in Pittsburg I had an opportunity of going carefully through the Westinghouse engine factory with Mr. Ralph Bagaley, the vice-president and manager, and of seeing all the details of construction of each of the different types of engines.

The Westinghouse Company make three styles of engine, each worked by a piston valve and single eccentric.

The standard type is so well known that I will not say anything about it. In it, as you are probably aware, the

steam-valve is between the cylinders, and set at a slight angle to them, while the cylinders are set rather over their work, and not directly in a vertical line above the crankshaft.

The junior and the new compound engines are on somewhat different lines to the standard, while the main principles involved are nearly the same. In these two later types the piston valve lies horizontally along the top of the cylinder heads. It is operated by a single eccentric working outside the engine case in a vertical direction, the motion being changed to a horizontal one by means of an L piece attached to the engine case by a hinge. The whole movement is of simple character, and works exceedingly well. In fact, there are practically no more working parts in the compound engine than in the junior or the standard two-cylinder patterns, and the one is as simple as the other.

The standard type has now stood the test of several years' work very satisfactorily, and there is no room to doubt that the compound engine, constructed in the same shops and by the same method as the standard engine, will wear at least as well. The makers' tests show exceedingly good results for this compound engine—viz., from 18½ lb. to 19½ lb. of water per brake h.p. hour with condenser, and from 24 lb. to 25½ lb. without condenser. I saw the testing apparatus in the makers' shops, and engines undergoing their test preparatory to delivery, and feel perfectly confident that the figures given by the makers are thoroughly reliable.

I will not describe this engine more fully, although to do so would probably elicit an interesting discussion, as it would be wandering from the subject of my paper. On the other hand, the remarks I have made are not intended to compare the Westinghouse compound engine with any other engine of at all similar type, but rather to draw the attention of electrical engineers to the fact that there are now, at any rate, two large firms of the highest repute turning out this class of engine, and ready to guarantee economy and efficiency on a par with Corliss engines.

Returning to the Pittsburg station, five Westinghouse engines of 250 i.h.p. drive five alternating-current dynamos of 2,500 16-c.p. lights capacity each, besides the machine driven from the Corliss engine. The exciters are run from smaller engines. The engines driving the alternating dynamos make 250 revolutions per minute, the dynamos making 1,050 revolutions per minute. The power is conveyed overhead by belts to the first floor, where the dynamos are placed. Each of these dynamos is on a sliding bed, so that the belt can be tightened, and, as I have already said, the exciters are run separately from the machines. The machines are so well known it is hardly necessary to describe them. I may, however, perhaps with advantage say a few words on the construction of the armature, which is the least easy part to understand from written descriptions or diagrams. In Prof. Silvanus Thompson's book on dynamo machines the diameter of the armature is given at nearly twice its breadth. While this is true of the smaller machines, in the 2,500 machine—which is the standard size for large stations, and is the size employed in the new station in Sardinia-street in London—the length of the drum is considerably greater than the diameter. The drum itself is formed of thin iron plates, just like an Edison armature, only of larger diameter; and as the iron near the centre is useless, holes are punched in the sheets, which lightens the armature and secures ventilation. Round the outside of this iron core, and over the two ends insulation is laid. As regards the coils of wire in which the current is generated they are made in this way: Beginning at the inner side of the coil the wire is wound on an oblong frame to correspond with the shape of the field-magnets, one turn on the top of the other. The coils are only one wire thick—that is, there is only one layer of wire between the drum and the field-magnets. When these thin flat coils are laid on the drum, the round ends of the coils are turned down at right angles over the edge at each end of the drum, and the connections from coil to coil are made. A small piece of wood screwed into the side of the drum, and projecting over the end of each coil, keeps it in its place. When all the coils are fixed in their places, sheets of mica are laid over them all round the

armature, and bands of fine wire with a little thicker insulation underneath them are bound round the whole armature at short intervals, in exactly the same way as is usual with the armatures of continuous-current machines.

(To be continued.)

ELECTRIC LIGHTING.

The following is a list of provisional orders definitely applied for:

Airdie	Leeds (3)
Acton and Ealing	Lancaster
Aberdeen (2)	Leicester
Aberdare	Liverpool
Ayr Burgh	Malvern and Leigh
Accrington Corporation	Manchester, Salford, and District
Ashton-under-Lyne	Margate and Westgate-on-Sea
Burnley	Morecambe
Blackburn	Metropolitan Electric Supply Company, Limited
Bury Corporation	Manchester (3)
Bacup Corporation	Malvern Link
Bristol (2)	Malvern
Barrow-in-Furness	Northampton
Birkenhead	Nottingham (2)
Bury	Newport, Mon. (2)
Barnsley (2)	Newcastle-upon-Tyne
Birmingham	North-West London
Bootle-cum-Linacre	North London (2)
Bognor	Norwich
Bournemouth (2)	Oldham
Brighton and Hove	Oxford (2)
Bedford	Preston and Fulwood
Bolton	Plymouth, Devonport, East
Crompton	Stonehouse, and Compton
Crystal Palace and District	Gifford
Cheltenham (2)	Portsmouth (3)
Coatbridge	Paddington (2)
Cardiff (3)	Preston
Carlisle	Partick, Hillhead, and Mary hill
Croydon (2)	Paisley Burgh
Cork	Plymouth
City of London (2)	Richmond, Mortlake, and Barnes
Chester	Reading (2)
Chadderton	Rochdale
Cambridge	Ramsgate and Broadstairs
Coventry	Richmond
Dover	St. James and Pall Mall
Darlington (2)	Stockport
Dewsbury	St. Martin-in-the-Fields and Strand
Dundee (3)	St. Helens
Edinburgh	St. Pancras
Eastbourne	Sunderland and Southwick
Edinburgh and Leith	Sevenoaks
Ealing	Southampton
Fleetwood	Scarborough (3)
Folkestone	Stafford
Fulham and Hammersmith	St. George's, Hanover-square (Belgravia and Pimlico)
Great Yarmouth	St. Giles and Strand
Glasgow (4)	Torquay
Hammersmith and Fulham	Torquay and District
Harrogate	Tunstall
Hull (2)	Tunbridge Wells
Hanley	Tiverton
Hawick	Windsor and Eton
Hove	Woking Electric Supply Co.
Hastings and St. Leonards.	Worcester (2)
Ipswich	Wandsworth
Kingston and Surbiton	Wigan
Kelvinside	Walsall
Kensington and Knightsbridge Electric Lighting Company	Wednesbury
London Electric Supply Corporation (City Order)	Wolverhampton
London Electric Supply Corporation	York (3)
Londonderry	
Lambeth	

NEW YORK NOTES.

(FROM OUR SPECIAL CORRESPONDENT.)

Something Novel for Telephone Men.
A New View of Telephone Induction.
Mr. Preece Caught Napping.
The Form and Efficiency of Incandescent Filaments.
Telegraph Line Adjustment.
Starvation of the Telegraph System on American Railways.
A New Gravity Cell.
The Statue of Liberty as a Bird-Trap.
Some Outspoken Comment on Mr. Edison's Famous Article at last.
Minor Notes—Fire, Funds, and Fumes.

NEW YORK, November 23, 1889.

At the last meeting of the American Institute of Electrical Engineers, Mr. C. J. Reed read a paper on the "Form and Efficiency of Incandescent Filaments." Mr. Reed gave out a number of mathematical formulæ for calculating the efficiency of a filament, his principal conclusion being that the efficiency depends upon the temperature of the filament, the temperature of the surrounding space, and the specific radiating power, and upon them only. The efficiency is constant, and is independent of the potential, current, length, radius, resistance, and candle-power of the filament. This means that the energy required to produce a given candle-power will be proportional to the candle-power, and will be the same, whether it is expended in driving a large current through a short, thick filament, or a small current through a long, slender filament; provided that the temperature or state of incandescence is the same, and that no heat is lost by conduction through the terminal wires. In this view Mr. Reed was sustained by Prof. Nicholls, who was emphatic in his belief that the temperature of the filament is the only factor in its efficiency; he also stated that, judging from the account of recent German researches which he had just read, he fully believed that before very long it will be possible to measure the temperature of incandescent filaments and thus obtain much needed data for this branch of investigation.

Following Mr. Reed's paper, one was read by Mr. P. B. Delany on "Telegraph Line Adjustment." Mr. Delany severely criticised the niggardly and dangerous policy pursued by American railway companies in respect to their telegraph service. Cheap and inefficient apparatus, poorly-constructed and badly-maintained lines, overworked and underpaid staff (in many instances composed of untrained boys), and lack of proper technical supervision are to be met with throughout the railway telegraph administrations of the country. Mr. Delany counsels less expenditure in drawing-room cars and other luxuries calculated to attract passengers, and more liberality in the proper equipment, both as regards men and material, of the telegraph system, on which the safety of travellers by rail so very largely depends. Finding the railway companies steadfast in their iniquitous policy of neglect in this matter, Mr. Delany came to the aid of the travelling public by inventing a little instrument which, when a fault caused by a rain-storm at any part of a long line causes the relays at way stations to be thrown out of adjustment, automatically breaks the circuit for an instant, thereby calling the attention of operators at way stations to the changed conditions of the line. This device is of course adapted for use on lines worked on the closed circuit system. Mr. Delany also described "A New Gravity Cell," in which the zinc electrode is enveloped in a paper covering, and the charge of sulphate of copper is placed in a cardboard box resting on the copper plate. This arrangement prevents the accumulation of dust, of cupric sulphate in the cell, and also the deposit of copper on the zinc, adding considerably to the life of the cell. A rubber band is cemented to the inner rim of the glass jar, which effectually prevents the creeping of zinc sulphate over the edge of the jar. In answer to a question, Mr. Delaney said that the internal resistance of the cell was not appreciably greater than that of the ordinary form, as the interposition of the paper envelope and the cardboard box allows a closer approximation of the zinc to the copper,

which compensates for any additional resistance due to the presence of the paper and cardboard.

At the meeting of the Chicago Electric Club, held last Monday, Mr. B. E. Sunny read a paper on "The Use of High-Tension Currents in Electric Lighting." Mr. Sunny's paper was an answer to Mr. Edison's recent alarmist article in the *North American Review* on "The Dangers of Electric Lighting." Mr. Sunny analysed the article in question, and disposed of Mr. Edison's strong points in a very effective manner. A long discussion followed the reading of the paper, and reference was made to Mr. Ferranti's Deptford installation as a proof that the high-tension alternating-current system is not viewed everywhere from Mr. Edison's standpoint. At the close of the discussion, Mr. Sunny proposed the following resolutions: "Resolved, that it is the sense of the Chicago Electric Club that the objections to, and the general condemnation of, the high-pressure systems of electric lighting set forth by Mr. Edison in an article in the November number of the *North American Review* are not sustained, and that the growth and popularity of the service furnished by this class of currents are in themselves a contradiction of Mr. Edison's conclusions; and further be it resolved, that with proper construction and exercise of reasonable intelligence, the high-pressure currents are absolutely safe." The resolutions were discussed at some length, and were finally adopted by a vote of 32 to 15. About 40 members present refrained from voting.

By way of minor notes I may mention that a fire broke out among the records and filed messages in the Western Union building early yesterday morning, causing considerable excitement. The fire was got under without much difficulty, and no damage was done to the wires or instruments. The World's Fair Fund received a handsome filip yesterday in the shape of subscriptions of 25,000dols. each from Jay Gould, the Western Union Telegraph Company, and the Manhattan Railway Company. The guarantee fund is now about four and a half million dollars. An old friend has turned up here in the appearance of the D'Humy water battery, which, accompanied by chickens and champagne and good cigars, was sprung upon a gathering of newspaper and technical reporters a few days ago.

ELECTRIC LIGHT NOTES FROM ALGERIA.

The public lighting of the town of Milianeh was effected until the month of February last by means of 56 petroleum lamps. The cost of these was 5.50f. per year, and the lamps were not lighted on moonlight nights. The repairs for wear and tear and other incidentals made up an outlay of 6,000f.

Now, Milianeh possesses a waterfall having a descent of 43 metres, and the Municipality decided to put up an electric light installation in a mill situated outside the town near by, and to make use of this waterfall.

The main cable of about 500 metres in length, and having a section of 100 square mm., takes the current to the centre of the town, from whence it is led by branch wires over a space of some 10 kilometres.

The lighting of the public streets is now done by 40 lamps of 20 c.p. each, and by 25 lamps of 50 c.p., besides some incandescent lamps of high intensity, of 200, 300, and 500 c.p., which serve to ornament some of the squares. All the municipal buildings, theatres, colleges, etc., and a large number of private houses avail themselves of the new mode of lighting.

The town of Milianeh has contracted for the establishment of 80 incandescent lamps, intended for the public lighting, for a sum of 33,000f. To this amount must be added 7,000f. for the purchase of a turbine and pipes for taking the water. In addition, the fixing of the turbine, the construction of the dynamo-room, the purchase of lamp-posts, brackets, and new lamps will make an outlay of about 15,000f.

To meet these expenses the Municipality has entered into a loan of only 40,000f., relying upon its ordinary budget to make up the difference. The annual outlay provided for is as follows:

Hire of mill at night (winter, from 4 in the evening to 7 in the morning).....	1,800
Wages for mechanic to work and look after the installation	1,800
Interest and sinking fund on loan of 40,000f.	2,700
Wages for inspector of line and for cleaning lamps	720
Wear and tear of lamps, oil, and sundries	900

Total f. 7,920

The petroleum lighting used to cost 6,000*l.*, and now, with lights of much more intensity, and running every night whether moonlight or not, the yearly outlay is only augmented by 2,000*l.* From this figure, too, should be deducted the rent to be paid by private houses, schools, and other subscribers. The subscription proposed is 36*l.* per lamp per year. This installation cannot be considered burdensome, especially as the town can dispose of suitable water power, and there is every reason to augur well for its future.

THE GILBERT CLUB.

The inaugural meeting of the Gilbert Club took place at the rooms of the Society of Arts, John-street, Adelphi, yesterday week. The chair was taken by Sir William Thomson, F.R.S. (president of the Institution of Electrical Engineers), and among those present were Sir Frederick J. Bramwell, F.R.S., Dr. B. W. Richardson, F.R.S., Prof. D. E. Hughes, F.R.S., Prof. John Perry, F.R.S., Prof. George Forbes, F.R.S., Mr. Latimer Clark, F.R.S., Mr. G. J. Symons, F.R.S., Dr. Atkinson, F.R.S., Mr. H. Trueman Wood, Dr. Laver, Mr. J. Lane, Prof. Silvanus P. Thompson, D.Sc. (hon. sec.), and Mr. Conrad W. Cooke (hon. sec.).

Prof. SILVANUS THOMPSON, who was called upon by the chairman to explain the objects and constitution of the club, said that it had seemed to those who were instrumental in establishing it that there were quite scientific societies enough in the world without creating another. What that club proposed to do was to commemorate the tercentenary of William Gilbert and his work, and to do honour to him by reproducing in English the great work which began the science of electricity. They thought it was better to invite membership upon that basis, leaving it to the future members to determine whether, in the event of the first venture being successful, they would thereafter embark upon other labours. Besides the immediate literature of Gilbert himself there was a very large amount of contemporary literature of very great interest to those who studied the early history of the sciences of electricity and magnetism; and it seemed that the Gilbert Club might possibly, in the event of its first work being successful, hereafter reproduce some of those other books. At the same time, it seemed undesirable to commit the club to anything more than the carrying out of the two specific objects—viz., to subscribe the English translation of Gilbert's work, "De Magnete," and form the nucleus of an organisation hereafter for the tercentenary celebration. The hon. secretaries had received letters regretting their inability to attend the first meeting from, among others, Lord Rayleigh, Sir J. Lubbock, Prof. Tyndall, Mr. J. Hutchinson, and Mr. Preece. He concluded by moving the first resolution constituting the club, which was as follows: "That the 87 persons who have already signified their acceptance of the invitation to be enrolled among the members of the Gilbert Club be hereby constituted members, together with such others of those who, having already received notice of invitation, shall signify their acceptance thereof before the close of 1889."

Dr. B. W. RICHARDSON seconded the resolution, and said that he did so with special pleasure, inasmuch as he had been an old student of Gilbert, had written a memoir of him, and had lectured on him several times. He did not know that English science could do better than recognise that distinguished man, the contemporary of Harvey, of Shakespeare, and of Bacon. Gilbert was physician to the Queen, and so bewitched her by his kindness and solicitude that he was the only person living to whom she left a legacy. His style of writing betrayed the philosopher in every page. His glory was that he went entirely upon experimental research, in which he really preceded Bacon. We had no more illustrious man in all our history of science than William Gilbert.

The resolution having been carried unanimously,

Mr. CONRAD W. COOKE moved the following: "That the objects of the Gilbert Club be as follows: 1. To produce and issue an English translation of 'De Magnete' in the manner of the folio edition of 1600. 2. To arrange hereafter for the tercentenary celebration of the publication of 'De Magnete' in the year 1900. 3. To promote enquiries into the personal history, life, works, and writings of Dr. Gilbert. 4. To have power after the completion of the English edition of 'De Magnete' to undertake the reproduction of other early works on electricity and magnetism, provided at such date a majority of the members of the club so desire."

Prof. FORBES seconded the resolution, which was carried unanimously.

After some discussion it was resolved, "That all proposals for membership be referred for the present to the council, hereafter to be chosen, for selection, up to the number of 200 in all."

Prof. HUGHES proposed and Sir FREDERICK BRAMWELL seconded the election of Sir William Thomson as president of the club, and the resolution was unanimously carried.

The following vice-presidents were then elected: Mr. Jonathan Hutchinson (president of the Royal College of Sur-

geons), Dr. Benjamin Ward Richardson, Lord Rayleigh, Dr. Henry Laver, of Colchester, Prof. Reinold (president of the Physical Society), and Prof. Hughes. The following gentlemen were elected to serve on the committee: Mr. Lant Carpenter, Prof. Ferguson, Sir Philip Magnus, Prof. Rücker, Prof. Foster, and Prof. Forbes. Mr. Latimer Clark was elected treasurer, and Mr. Conrad W. Cooke, Mr. Raphael Meldola, and Prof. Silvanus P. Thompson, hon. secs. The meeting terminated with votes of thanks to the Society of Arts and the chairman.

COMPANIES' MEETINGS.

ELECTRIC CONSTRUCTION CORPORATION.

An extraordinary general meeting of the Electric Construction Corporation, Limited, was held on Thursday, Nov. 26th, at the offices, Worcester House, Walbrook, under the presidency of Sir Douglas Fox (chairman of the corporation).

The **Secretary** (Mr. F. Walton) having read the notice convening the meeting,

The **Chairman** said: Your Directors are sorry, gentlemen, to have given you the trouble to come here to-day, as we met so recently, but I don't think you will consider the reason of our calling you together unsatisfactory. We have duly applied, as we promised we would, to the Stock Exchange for a quotation of this Company's shares, and you are convened this afternoon for the purpose simply of passing some very formal resolutions to meet the requirements of the committee of the Stock Exchange. That is the whole business before us to-day; but, at the same time, I think, as we have the opportunity of meeting you, it may be interesting to you to know that since we last met all the purchases of the properties comprising this Corporation have been completed, that the general business of the Company is proceeding in a manner thoroughly satisfactory to your Directors, and that it shows every sign of realising to the full the expectations which we formed in regard to it. Having first said that much, I will proceed with the formal business of the meeting. I propose to move, therefore, "That the articles of association be amended, except as to Article 8 (which is the second in the list), in accordance with the terms of the notice convening this meeting, dated November 19, 1889, as follows:

1. That Article 8 of the articles of association of the Company be amended by inserting after the word "place," in the first line thereof, the words "in the United Kingdom."

2. That the following article be added after Article 8: "(8A) No part of the funds of the Company shall be employed by the Directors of the Company in the purchase of the Company's shares."

3. That Article 19 be amended by inserting after the word "shares," in the second line thereof, the words "not fully paid."

4. That Article 25 be amended by adding at the end of the article the words, "no call shall exceed one-fourth of the nominal amount of a share, and two months at least shall intervene between the time appointed for the payment of one call and that appointed for the payment of the next succeeding call (if any)."

5. That Article 31 be amended by omitting from the seventh, eighth, and ninth lines thereof the words "or regulated by the amount of dividends from time to time to be paid by the Company, or its not divisible profits."

6. That Article 35 be amended by omitting from the fifth line thereof the words "whether fully paid-up or not," and inserting in lieu thereof the words "not fully paid-up."

7. That Article 88 be amended by omitting the whole of the article, and inserting in lieu thereof the words, "The qualification of a Director shall be the holding of shares of the Company of the nominal amount of £1,000. A first Director may act before acquiring his qualification, but shall in any case acquire the same within one month from his appointment, and unless he shall do so he shall be deemed to have agreed to take the said shares from the Company, and the same shall be forthwith allotted to him accordingly."

8. That Article 105 be amended by inserting after the word "shall" in the seventh line thereof the word "not," and by omitting from the seventh line thereof the words "sit at the Board and," and by inserting in the ninth line thereof the words "in which he is," in lieu of the words "notwithstanding his being," and by omitting from the ninth line thereof the word "therein," and by omitting from the tenth and eleventh lines thereof the words "but he shall not be bound to disclose the extent of his interest."

9. That Article 130 be amended by adding at the end of the article the words "other than the shares of the Company."

The **Chairman** read the various articles in their amended form, and added that the alterations were all of a purely formal character.

Sir Daniel Cooper seconded the motion, which was put and carried unanimously.

The **Chairman** next formally moved that Article 8a in the notice be amended as follows: "No part of the funds of the Company shall be employed by the Directors of the Company in the purchase, or in loans upon the security, of the Company's shares."

Sir Henry Mance seconded the proposition, which was also unanimously agreed to.

The **Chairman** then thanked the shareholders for their attendance, and intimated that it would be necessary to call another meeting for the purpose of confirming the resolutions.

The proceedings then terminated.

National Telephone Company, Limited.—An interim dividend at the rate of 6 per cent. per annum is announced by the Directors of this Company for the six months ended October 31.

NEW COMPANIES REGISTERED.

Birmingham Electric Supply Company, Limited.—Registered by Waterlow Bros. and Layton, Limited, 24 and 25, Birch-lane, E.C., with a capital of £100,000 in £5 shares. Object, to purchase, on such terms as may be thought advisable, a transfer of the Birmingham Electric Lighting Order, 1889, and of the rights and powers conferred thereby, and to accept such transfer, and to exercise and carry out such rights and powers, and to observe and comply with all arrangements or conditions attached to such transfer, and with the provisions contained in the said order; to generate, produce, sell and supply electricity for all purposes. The first subscribers are:

	Shares.
G. Albright, The Elms, Edgbaston	1
G. H. Johnstone, 38, Northampton-street, Birmingham	1
F. W. V. Mitchell, The Birches, Edgbaston	1
J. F. Albright, C.E., Edgbaston	1
Sir D. Ratcliffe, Thursaston Hall, Cheshire	1
E. M. Sharpe, Beech Mount, Edgbaston	1
F. M. Radcliffe, 9, Dock-street, Liverpool	1

There shall not be less than three nor more than nine Directors; the first to be appointed by the subscribers. Qualification, £500; remuneration, £350, divisible.

Ecuador Central Railway Company, Limited.—Registered by Ashurst Morris, Crisp, and Co., 6, Old Jewry, E.C., with a capital of £115,500 in £10 shares. Object: to contract and work railways, tramways, lines of telegraph and telephones in Ecuador or elsewhere. The first subscribers are:

	Shares.
E. H. Marquis, 141, Brook-road	1
A. A. Hargreaves, Cheshunt	1
E. W. Clements, Wolverton-street, Broadstairs	1
J. Strickland, 30, Stanley-road, Edmonton	1
W. H. Williams, 60, Fellerstone-road, Kensal Green	1
B. L. Holme, 22, Woburn-place, W.C.	1
H. H. Parson Smith, 22, Westbourne-park-crescent, W.	1

There shall not be less than three nor more than seven Directors. The first to be appointed by the subscribers to the memorandum of association. Qualification, £250; remuneration to be determined in general meeting.

CITY NOTES.

West Coast of America Telegraph Company.—The receipts for the month of November amounted to £6,600.

Direct Spanish Telegraph Company, Limited.—The receipts of this Company for November were £2,497, against £1,950.

Eastern Extension Telegraph Company.—This Company's traffic receipts for the month of November were £44,147, as against £45,234 for the same period of 1888.

Eastern Telegraph Company.—The traffic receipts of this Company for November were £60,578, as against £59,862 for the same period of 1888, or an increase of £716.

West India and Panama Company.—The traffic receipts for the half-month ended November 30 were £3,089, against £2,969. The August receipts, estimated at £4,502, realised £4,529.

Western and Brazilian Telegraph Company, Limited.—The traffic receipts of this Company for the week ended November 29, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,259.

Brazilian Submarine Telegraph Company, Limited.—This Company have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, tax free, for the quarter ended September 30, payable on the 24th inst. The receipts of the Company for the week ended November 29 amounted to £5,931.

PROVISIONAL PATENTS, 1889.

NOVEMBER 25.

16855. **An automatic attachment for electrical switches, gas and other taps or cocks, valves, &c.** Frederick William White, 4, Great Winchester-street, London.

18886. **Electric plated steel safety clip and coupling for india-rubber tyres.** Frederick William Bennett, 48, Crompton-road, Penge, Surrey.

18897. **An improved quick-make and quick-break switch for electrical purposes.** Joseph Grace Smith Cunningham, 4, Holly Mount, Hampstead Heath.

18900. **Improvements in switches for electrical circuits.** Walter Claude Johnson and Samuel Edmund Phillips, 28, Southampton-buildings, London.

NOVEMBER 26.

18939. **Improvements in and connected with railway and tramway vehicles and with their propulsion by means of electricity.** Henry Percy Holt, 70, Market-street, Manchester.

18953. **An improved electrode for secondary batteries of accumulators.** George Macaulay-Cruikshank, 62, St. Vincent-street, Glasgow. (William Asahel Johnson and James Norman Smith, Canada.) (Complete specification.)

18966. **Improvements in primary or galvanic batteries.** Oscar Axel Enholm, 23, Southampton-buildings, Middlesex. (Complete specification.)

18979. **Improved regulator for electric currents.** Wenzel Robert Michl, 41, Eastcheap, London. (Complete specification.)

18989. **Improvements in secondary or storage batteries.** Walter Francis Smith, 323, High Holborn, London. (Complete specification.)

18997. **Improvements in or relating to the connecting of an accumulator battery in alternating current circuit.** Alfred Julius Boulton, 323, High Holborn, Middlesex. (August Foepl, Germany.) (Complete specification.)

19004. **Improvements in suspenders and holders for electric glow lamps.** William White, 28, Southampton-buildings, London. (Complete specification.)

19011. **Improvements in dynamo-electric machines.** John Hopkinson, 47, Lincoln's-inn-fields, London.

NOVEMBER 27.

19079. **Improvements in electrical instruments.** Frank Bryan, 83, Queen Victoria-street, London.

19080. **An improved construction of plates for secondary or other voltaic batteries.** Henry Tyrer Cheswright, 28, Southampton-buildings, London.

NOVEMBER 28.

19108. **An improved instrument for registering electrical currents.** William Henry Douglas, 7, Cherry-street, Birmingham.

19129. **Improvements in electric dry batteries.** Christen Rees Bonne, 41, Eastcheap, London. (Heinrich Meinecke, junior, Germany.) (Complete specification.)

19135. **An improved lock-switch for switching on and off the electric current.** George Augustus Graham, 2, King's Arms-yard, Moorgate-street, London.

19142. **Improvements in continuous current transformers of electrical power.** John Hopkinson, 47, Lincoln's-inn-fields, London.

19155. **Improvements in and relating to electro-motors.** Rankin Kennedy, 96, Buchanan-street, Glasgow.

NOVEMBER 29.

19190. **Improvements in and relating to induction coils and other electro-magnets.** Edward Lovell Lovell and Arthur Ford Lloyd, 27, Bow-lane, Cannon-street.

19195. **Improvements in and relating to the laying of electric and other wires in streets and roads.** Richard Summers, 4, South-street, Finsbury, London.

19199. **Improved means for the prevention of polarization in electric batteries.** Henry Badcock, William Grunsell, and Archibald Walker, 1, Quality-court, London.

19216. **Improvements relating to the generation, distribution, and utilization of electrical currents.** Francis Jarvis Patten, 45, Southampton-buildings, London. (Complete specification.)

19220. **Improvements in distributing electricity with alternating currents and apparatus therefor.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, London. (Alfred Miles Taylor, India.)

NOVEMBER 30.

19283. **Improvements in apparatus for measuring electricity.** Leslie Bradley Miller, 46, Lincoln's-inn-fields, London.

19285. **New or improved ships' electrical signalling apparatus.** James Campbell, 212, St. Vincent-street, Glasgow.

19293. **Improvements in electro-sympathetic clocks.** David Fairgrieve, 20, High Holborn, London.

SPECIFICATIONS PUBLISHED

1888.

18137. **Switches for electrical currents.** Hartnell. 11d.

18784. **Regulating electric currents, &c.** Lahmeyer. 11d.

1889.

85. **Dynamo-electric machines.** Poleschko. 8d.

997. **Secondary batteries.** Cuttriss. 6d.

7919. **Electric lamp roses, switches, &c.** Grocott. 8d.

15045. **Electric switches, &c.** Dorman and Smith. 8d.

15819. **Electric batteries.** Smith. 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name	Paid.	Price Wednes- day
12 Feb.	1/2	Anglo-American Brush E.L.	—	4
12 Feb.	2/0	— Pref.	—	2½
14 Nov.	0/4½	Con Telephone & Main ...	1	3
27 July	10/0	India Rubber, G. P. & Tel.	10	17½
.....	.....	House-to-House	4½	5
.....	.....	Metroptn Electric Supply	—	5
.....	.....	London Electric Supply ...	5	1½
.....	.....	Swan United	3½	5
2 July	12/0	Telegraph Construction ...	12	45
2 July	6/0	— 6%, 1889	100	105
.....	.....	National Telephone	5	6½

NOTES.

Underground Cables.—Berlin has now 100 miles of underground electric light cable.

Barnsley.—The cost of an installation to light the centre of the town has been estimated by the authorities at £33,000.

Society of Arts.—On Wednesday next, Sir Robert Rawlinson, K.C.B., will read a paper on "London Sewage," Sir Henry Roscoe, F.R.S., in the chair.

Philosophical Transactions.—We have received a copy of Dr. John Hopkinson's paper on "Magnetic and other Physical Properties of Iron at High Temperature."

Electric Pipe Welding.—The McKeesport National Tube Works are introducing electric welding both for large and small iron pipes, for uniting the edges of the bent metal.

The "Gymnote."—It is stated that fresh trials of the "Gymnote" has been made at Toulon with success, under the direction of the lieutenant of the ship "Baudry de la Continerie."

Cost of Electric Railways.—The cost of the new line to be built between Greenfield and Turner Falls in Massachusetts, on the Thomson-Houston system, is given at £1,000 a mile.

Bradford.—Alderman F. Priestman, chairman of the Gas and Electricity Supply Committee at Bradford, states that the number of customers is increasing every day, and that the installation will be working at full load by Christmas.

Cadiz.—A concession has been awarded on Nov. 25 for the public lighting of the streets of Cadiz by electricity. The concession is for 25 years dating from November 26, 1890, and the price is not to exceed 2½d. per lamp-hour of 16 candles.

Charing Cross Shops.—Permission has been given by the London County Council to the Metropolitan Electric Supply Company to lay a service cable from the main in Northumberland-avenue subway to the shops under the Grand Hotel.

Outside Lamps.—The increasing demand for outside lamps has induced the Street Lamp Company, of Broad-street, Birmingham, to start business upon this one speciality, and they will devote themselves entirely to street and ornamental lamps, both for gas and electric light.

Paris Concessions.—The Municipal Council of Paris have fixed the charge of 7,000f. annually upon each electric light company obtaining a concession for the lighting of Paris, as the cost of supervision during the time that the work of laying underground mains in the public streets continues.

Versailles.—Several propositions have been made for the public and private lighting of Versailles by electricity. The concession will shortly be awarded, and the companies who desire, either themselves or through their agents, to submit offers should address the Mayor of Versailles before the 25th of this month.

Dissolution of Partnership.—We are notified that the partnership hitherto subsisting between Messrs. Thompson and Rew, of 13, Victoria-street, Westminster, terminated on 30th of November, by the effluxion of time,

and that henceforth the business will be carried on solely by Mr. N. G. Thompson.

The Globe Theatre.—Mr. F. R. Benson, who opens the Globe on the 19th inst. with "Midsummer Nights Dream," has decided to have the electric light, and Messrs. Woodhouse and Rawson United, Limited, are well forward with the work. We hear this firm has secured several other orders in the Strand district.

O.S.A. Soiree.—The president and past-presidents of the City Guilds Old Students' Association will give a soiree on Thursday, December 19, at which there will be phonograph, music, and dancing—evidently a very enjoyable evening is to be passed. It is to be held at the rooms of the Institute of Medical Electricity, 24A, Regent-street, W.

The "Peral."—Despatches from Cadiz state that the electric submarine torpedo boat of Captain Peral has been again tried, the greatest secrecy being still maintained. On December 5 the boat was submerged, leaving no sign upon the surface of the water, and rising again after an immersion of 11 minutes amidst the indescribable enthusiasm of the spectators.

Edinburgh Electrical Exhibition.—The Brush Electrical Engineering Company, Limited, of 112, Belvedere-road, Lambeth, have secured the contract for the whole of the arc lighting at the forthcoming Edinburgh Exhibition. The lighting will be effected by means of about 350 Brush arc lamps, each of 2,000 nominal candle-power, run in series from Brush dynamo machines.

Luminous Fountains at Vienna.—It has been determined to hold an exhibition of agriculture at Vienna next spring and the municipal authorities have asked that luminous fountains, constructed upon the model of those which have had so great a success at the Paris Exhibition, should decorate the park where the exhibition will be held. Vienna will thus be the third city of Europe with luminous electric fountains.

Wigan.—At the last meeting of the Wigan County Borough Council it was resolved to apply for an order, it being acknowledged that the principal object of the application for powers was to prevent any other company establishing themselves in the borough. Instructions were given to the clerk to take the necessary proceedings, and for the seal of the Corporation to be affixed to the memorial to the Board of Trade.

Hall-sur-Saal.—The German town of Hall-sur-Saal has determined to establish a central electric lighting station, and a deputation has visited Berlin, Hamburg, and other towns now lighted electrically. One year is allowed for consideration and arrangement of the system and details of distribution, and the committee of the gas and water works, which belong to the town, are requested to furnish a report at the end of the time.

Electric Launches.—We hear that Messrs. Immisch will run their electric launches on the canal, carrying passengers to and from the Edinburgh Exhibition, and in excursions westward from the building. Besides being a great convenience to visitors to the exhibition, this should prove an effective demonstration in Scotland of the application of electric motors for propelling boats, which has been already so successfully demonstrated on the Thames.

Messrs. Barker and Co.—With reference to the installation of electric light in the premises of Messrs. J. Barker and Co., of High-street, Kensington, which was

recently made the occasion of a grand ball, it should be stated that the whole of the installation was carried out by Messrs. W. T. Goolden and Co., of Woodfield road, Harrow-road, the Planet Electrical Engineering Company supplying the arc lamps which were employed in the installation.

London Subways.—At the meeting of the London County Council, the Parliamentary Committee recommended that the seal of the Council be affixed to the petition for leave to bring in the London Subways and Overhead Wires Bill (the heads of which were agreed to by the Council on the 22nd and 29th of October last), and that the Bill be deposited with the petition with such verbal alterations as the committee consider desirable.

Brussels.—The Tudor Electrical Company, who will have shortly finished their central electric station of the Rue Montagne aux Herbes-Potageres, will install another central station destined principally to furnish light to a new immense building in the Place de Brouckere, which it is mentioned will not be connected with the gas supply, but depend entirely upon the electric light. The price is fixed at 0.72d. per 100 watt-hours, without other charge either of installation or of renewals.

Worcester.—A meeting of the City Council was held at Worcester last week, at which the mayor moved the adoption of recommendations of the Watch Committee that the Council apply to the Board of Trade for a provisional order authorising them to supply electricity for public and private purposes in the city, and that the capital in connection with the undertaking be £15,000. It was stated that the resolution would not bind the Council to carry out the work. The resolution was carried.

Italian Tramways.—The subscription to the Lodi Electric Tramway Company will remain open till 21st inst. The line as projected by the engineers, Signori E. Pandiani and P. Toncada, of Milan, will have a length at first of 20 kilometres (12½ miles), and is expected to be a very profitable investment. The enterprise is the subject of great interest, as it is the first electric railway in Italy, and if it prove as great a success as anticipated it will no doubt be the precursor of a great development of electric traction in that country.

Municipal Control.—It is stated that the Wash-ton branch of the Nationalists has been carrying on an extensive correspondence with the principal municipal authorities, and will memorialise Congress asking that the control of this necessity be taken out of the hands of private corporations. The figures obtained prove that the cost of arc lights of 2,000 nominal c.p. under private control ranges from 11.5 to 304d. per night, while the cost of those under public control is from 6.5 to 10d. per light of the same power.

Jablochkoff Battery.—M. Jablochkoff has furnished the Société des Ingenieurs Civils with the model of a new primary battery consuming iron, which he fondly believes will supplant the dynamo. The battery is said to be interesting from a theoretical point of view, but M. Hospitalier, in a note to the *Bulletin* of the Société throws doubt on the accuracy of the figures given by M. Jablochkoff, who neglects to give the E.M.F. and consumption of the battery, though he states the cost to be 1d. to 1½d. per horse-power hour.

The First Submarine Telephone Cable.—The inauguration has just taken place of a submarine telephone cable, of the length of 32 miles, between Monte Video

and Buenos Ayres. With the overhead line the total length is 180 miles. On this line there are five intermediate stations, all of which, being fitted with the Van Rysselberghe system, can telephone and telegraph simultaneously with all the other stations. The work has been carried out by M. Laborde for M. Acampo Samanes, the promoter of the enterprise, with the assistance of MM. Murlon and Van Rysselberghe.

Roller Bearings.—A type of frictionless bearings, named the Tripp roller bearings, is being largely introduced among American electric companies. These bearings have been applied to the trolleys of a number of the cars of the West End street railway, and also of the Albany street railroad. The Chicago electric company have used them with great success on their line-shafting, and a number of bearings have been sent to the Thomson-Houston factory at Lynn. As these bearings require oiling only about once a year, and develop no heat, being almost without friction, they should be valuable for numerous electrical enterprises.

Paris Theatres.—Several of the theatres of Paris not subventioned by the State have prepared a memorial protesting, rightly or wrongly, against the expense they are now put to by the regulations insisting upon the use of an ignifuge varnish. This they state is very dear and soon becomes useless. It would be much simpler to insist upon electric light in all theatres, which would get rid of all danger of fire. In the theatres already possessing electric light the ignifuge is superfluous, and in the others it is a useless luxury whose efficacy is more than doubtful. Electric light would be far more preferable as a safeguard to the public.

Telephones in Scotland.—Mr. A. R. Bennett, the manager of the National Telephone in Scotland, has sent us a map showing the latest progress in the intercommunication by telephone between the chief Scottish towns. This shows main trunk lines from Hawick, by Edinburgh, to Falkirk, Coatbridge, Glasgow, and down to Ayr, and northward to Stirling, Kirkcaldy, Cupar, to Dundee, and on to Aberdeen. Numerous lines are shown projected, a main trunk line between Dumfries and Carlisle, and extensions to a number of smaller towns on the other side of the Firth of Forth, evidencing the continued enterprise of the company in Scotland.

Southwark Subway.—The experimental train on the Southwark Subway electric railway has been running for about a fortnight successfully over a portion of the route. It was hoped that this line would have been ready some time ago, but the soft soil encountered in the bed of an old river has considerably delayed a portion of the line. From what may be gathered, it is thought the line will be opened to traffic about next March. The terminus at the Monument is finished so far as regards the building, and the company have taken up their permanent position in the offices above. The line is still in the hands of the electrical contractors, Messrs. Mather and Platt.

The Glasgow Victoria Infirmary.—The second annual meeting of the court of contributors of the new Victoria Infirmary of Glasgow was held in the Merchants' Hall on December 5th, Sir James King presiding. The report by the governors stated that the buildings were now far advanced, and that their completion and opening might be expected some time next January. Accommodation will be found for 80 patients. The principal wards, corridors, and staircases will be lighted by electricity, which, with the improved system of

heating and ventilating adopted, the governors believe will be greatly conducive to the health and comfort of the patients.

Electric Tramcars at Barking.—The five cars of the Electric Traction Company continue to operate entirely the Barking-road section of the North Metropolitan Tramway, doing 300 miles daily—i.e., 60 miles each car, with one change of accumulators. The tramway world is awaiting with the greatest interest the statistics of the North Metropolitan Tramway Company as to the working expenses, and we understand that experience so far leaves little doubt that the rate per car mile run will come out considerably less than horses. This being so, we may confidently expect that in any future practical installation of electric traction advantage will be taken of the experience gained at Barking to still further reduce the working expenses.

Ferranti Cables.—We see it has been stated in print that the Ferranti cables have broken down, and that Fowler-Waring cables have been substituted. This report is quite contrary to the fact, and has probably arisen from the simple reason that the Ferranti cables not being ready, Fowler-Waring cables have been used, and can be seen spanning the railway arches at Charing Cross. These, however, are used as a temporary connection. The Ferranti cables are being made in some quantities in 20ft. lengths, as already described, and have always stood the most severe test that can be desired—namely, simply to connect them to a circuit of two 10,000-volt transformers in series, making a potential of 20,000 volts, twice as much as they will require to stand in actual use.

Electrically Welded Cables.—An interesting instance of the promised invasion by electricity of all fields of industry is that afforded by the help that it has been called in to give to its rival in traction, the cable tramway. Recently, the Thomson Electric Welding Company, at their Lynn Works, have been able to weld wire cable $1\frac{5}{16}$ inches in diameter for a cable to be used on a cable railroad, showing greater efficiency than was thought possible in doing this very difficult work. The strength of joints obtained in the ordinary method by splicing was about 30 per cent. that of the original cable, and it was found from tests made at the Watertown arsenal of electric welds made of this cable, that 87 per cent. of the efficiency of the rope itself had been obtained in these welds.

Death of Pacinotti.—Prof. Luigi Pacinotti, well known in electrical circles, has just died at Pisa. He was born at Pistoia in 1807, so that he was in his eighty-second year. Almost from his earliest youth he manifested peculiar aptitude for the study of mathematics, and up till the year 1831 continued his studies at the college at Pisa with extraordinary assiduity, obtaining in that year the chair of experimental physics in the university. Pisa owes to him the world-wide status in the scientific progress which received the eulogiums of the congress of Italian scientists which met in 1840. In 1841 great impetus was given to mathematics and a new chair was instituted, and Pacinotti received the appointment of professor of experimental science. His name is best known in this country in connection with the now classical "Pacinotti ring."

Eastbourne.—The meeting of the Eastbourne Town Council, last week, had to consider the application of the Eastbourne Electric Light Company, Limited, for a provisional order to supply electric light in the borough. When the time came, no one rose to move the resolution in

favour of granting the application, and a resolution was then proposed by Mr. Pearce that before the Council give their consent to the proposed provisional order it be referred to a special committee to report upon, with power to call in such professional assistance as they may deem necessary in the consideration of the matter. Mr. Home-wood, who arrived late, then proposed the motion originally intended to be before the meeting to grant the application, but this was negatived, and Mr. Pearce's resolution was carried, and a committee was thereupon appointed.

Electric Brake.—Trial was made at Birmingham on the London and North-Western Railway of the electric brake designed by Prof. Forbes and Mr. Illius A. Timmis. An entire train of carriages fitted with it are being constructed by Messrs. Brown, Marshall, and Co., of Adderley Park, for use on a line in Russia. The brake acts upon a thick iron disc several inches in depth bolted to the inner face of the wheel. Opposite this is another which encircles the axle loosely, and is fixed so that it cannot revolve with the wheel. This second disc is arranged as an electromagnet with a powerful coil, and on making the circuit it is attracted to the wheelplate, arresting its motion and so acting as a brake. The chief gain is in point of rapidity of action. A train of average length will feel the brake power throughout its length almost instantaneously as against three or four seconds required by the vacuum brakes.

The Pulsion Telephone.—A mechanical telephone which really seems as if it might rival the ordinary telephone, at any rate for moderate distances, has been recently exhibited on a $3\frac{1}{4}$ miles line, between Finchley-road and Hendon, on the Midland Railway, under the name of the "Pulsion Telephone." It is the invention of Mr. Lemuel Mellett, of Boston, U.S. The principle seems to be to have on the resounding-plate a number of small coiled springs held at one end only; these respond to various harmonic vibrations, and the vibration of the wire is taken up and reinforced, giving great distinctness of utterance. It seems not to matter much whether the wire is twisted or passes through loose earth. One peculiarity is that it can be tapped at any point by resting a hat upon the wire, a useful quality in case of accident, though evidently unfitting it for private messages. Sir Edward Reed, M.P., is named as chairman of the proposed company to be formed to work the invention in England.

Electrical Cards.—We have received a second batch of the electrical engineering cards which are being published from week to week by the General Electric Company, Limited, being pocket information of useful kind. The first of these cards contains details of the latest forms of porcelain ceiling rosettes; also pendant accessories, such as beads, counterweights, and pulleys; and brass galleries and caps for shades. A second contains list of the usual sizes of flexible cords for table and pendant lamps; a stronger form, for factory use and for running over pulleys, also a special quality, asbestos covered. The third card contains list of standard Edison fittings, sockets with or without switch, cut-outs with glass fusible screw plugs, and wall sockets with plug for movable fittings. The last card contains jointing materials and sundries, tape, solution, solder, and cleats, with details of supply. To those who are constantly carrying out installations these handy means of reference will be very acceptable and useful.

Belgian Exhibition.—The prospect of a Belgian exhibition at the classical grounds of Earl's Court next

year has put joy into the hearts of the worthy engineers, merchants, and manufacturers of that peaceful and busy country. In the great Paris Exposition their exhibits, though in themselves magnificent and emblematic of the energy of the country, could not but be almost lost in the vast wilderness of machinery in the Palais des Machines. Now, however, that they will have the whole field to themselves, we may expect to see in a manner which all can realise an exhibition of their products, which can hardly fail to be most interesting. The enterprise seems to be already well taken up in Belgium, and the promise of a subsidy of 500,000*f.* towards the expense by the Belgian Government is an indication of what will be undertaken. The address of the official authorities of the exhibition is M. le Ministre de l'Agriculture et de l'Industrie, 3, rue de l'Orangerie, Brussels. It is stated that special rates of transfer will be arranged from Antwerp or Brussels to the exhibition.

Lambeth.—The clerk to the Lambeth Vestry reported last meeting that four plans relating to the electric lighting of the whole or parts of the parish had been deposited at the Vestry Hall—viz., by the Electric Supply Corporation, Limited, for so much of the parish as lies south of the Westminster Bridge-road; Metropolitan Electric Supply Company, Limited, for the whole parish; the House-to-House Electric Light Supply Company, for the whole parish; and by the Electric Construction and Maintenance Company, Limited, for the Crystal Palace, and an area surrounding it, including a very small portion of the parish at Westow-hill, consisting only of Westow-hill, Woodland-road, and parts of Lavender-hill, Woodward-hill, and George-street. Also two subway schemes—viz., a continuation of the existing subway from The Swan at Stockwell underneath the Clapham-road, to The Pavement, Clapham; and a subway from The Elephant and Castle, along St. George's-road and Lambeth-road, and then under the River Thames, and by Charing Cross to Camden Town. The various plans were referred to the Electric Lighting and other committees.

Artistic Fittings.—One of the handsomest standards we have seen lately is on view at the General Electric Company's rooms. It is a tall lamp with yellow silk and lace shade, and the standard itself is in artistically-painted porcelain, mounted in elaborately chased ormolu in the Louis Seize style, the lampholder and switch being to match. It would well grace the room of the richest mansion, and the soft rich light given through the straw-coloured silk gives an air of delightful repose. We also have seen some pendant fittings just brought out by this company, which should commend themselves to those, now numerous, who are engaged in fitting up the better class of residential houses. These are rosettes, and corresponding balance weights in porcelain, fitted with porcelain wheels for the counterweight pendants. They are manufactured in very artistic colours, and delicately traced with sprays of leaves or other pattern in relieved gold. The artistic effect is very pleasing, and where counterweight pendants are used there will evidently be considerable scope for these porcelain fittings, both on account of their appearance and also of their greater safety to those often used with wheels of brass or other metal.

London Inspectors.—It appears that three persons are to be appointed by the London County Council to watch over the electric lighting enterprises of London—a competent inspector at £200 a year to test meters and to

discharge the duties under the Electric Lighting Act, a caretaker at £2 a week to attend to the instruments and accumulators, and a supervisor at £3. 3*s.* a week to supervise the work of the electric lighting companies in the public streets, and to see that the requirements of the Council are complied with. The salary for inspector at £200 a year does not seem excessive when it is considered that the person appointed will fill a very responsible position, and must be a thoroughly competent electrical engineer with practical and testing experience. The charge for testing meters can be charged for at the Council's own rates. It is understood that the Board of Trade would appoint officers in the absence of the Council so doing and have power to charge the salaries upon the rates. The London County Council, however, feel it very important to keep the power in their own hands, and we trust such persons will be selected as will possess the confidence of both the public and the electric lighting companies.

Glasgow.—At the meeting of the Glasgow Town Council on Monday, in accordance with notice, the following resolution was submitted: "That the Lord-Advocate having advised the Board of Trade that the Lord Provost, Magistrates, and Council (Police) are, in his opinion the local authority for electric lighting purposes, under the Electric Lighting Acts, 1882 and 1883, and seeing that the Corporation themselves are applicants for a provisional order, the police authorities resolve to refuse their consent to any company obtaining powers within any part of the municipality of Glasgow; and, further, to oppose any application by any company for such powers, and that it be remitted to the Parliamentary Bills Committee to take such steps as they may deem proper to carry out this resolution." Mr. M'Laren, in proposing the resolution, said it was their duty to oppose all speculative companies. While the Act of 1882 was rather restrictive regarding these companies, last year's Act opened the door so wide that now they were inundated with them. He understood Mr. Lang had had 10 such companies coming forward and giving notice of their intention to apply for provisional orders to light the city. The motion he had submitted, he explained, was only to keep them in proper form. The motion was adopted.

Electric Light at Hetton Colliery.—The Hetton Coal Company seem to appreciate pretty highly the advantages of the electric light for coal-mining purposes. They have just had 80 more lights of 16 c.p. each installed at their Eppleton Colliery, making a total of about 160 lights in the one pit. At Lyons Colliery they have already 140 lights of 16 c.p. each, and at Elemore Colliery (renowned for its disastrous explosion of a few years back) they have 80 lights of 16 c.p. underground, besides five arc lamps on the surface. At the Eppleton Colliery, where the new work has just been completed, they have two dynamos, one in the Maudlin seam, and one in the Main Coal seam, each working at 110 volts, and so arranged that by means of switches either dynamo can furnish current to either seam. This is taken advantage of at night, when there are only a few lights wanted in each seam, by putting all the work on the Maudlin dynamo, and stopping the Main Coal dynamo till morning. At the danger points, beyond which no naked lights are to be taken "in bye," ruby lamps are fixed in such a manner that the most careless miner's attention must be attracted. The installation was designed by the company's engineer, Mr. G. W. Ross, in conjunction with Mr. Sydney F. Wa-

ker, by whose firm all the various installations have been carried out.

Dock Central Stations.—It is stated that in the forthcoming navy estimates a sum of money will be asked for the establishment of central electric light stations for the use of ships in the Portsmouth Dockyard. The yard is not only in itself a great shipbuilding establishment, but numerous vessels are sent round from other dockyards to complete for sea there. Under the best of circumstances, the work below decks in ships after being launched is comparatively slow in consequence of the obscurity in which it is carried on; the men have nothing better than tallow dips to light them while employed in the lower portions of the hulls. When the new work in progress is so far advanced towards completion that the steam power of the ships can be brought into requisition, or where ships are docked for repairs, it is customary to make use of electric lamps. But in order to produce the light it is necessary to keep one or more boilers constantly under steam and the dynamos running, with proportionate wear and tear of machinery and expenditure of labour and fuel. These are some of the inconveniences attaching to the normal operations of the establishment, but it is obvious that in periods of emergency, when it would be of paramount importance to get ships ready with the utmost despatch, the work of preparation would have to be continued throughout the night. For this eventuality there is at present no adequate provision made. It is now proposed, it is understood, to erect central electric stations in connection with the various docks and basins, so that ships repairing, refitting, or completing for sea may be brought close at hand and their own wires connected with the stations, whereby an easy and convenient installation may be effected. A similar advantage will be obtained by the supply of power by electric motors for gun-drill of heavy ordnance or movement of heavy machinery, now often done by means of compressed-air mains.

Okonite Wire.—Messrs. Laing, Wharton, and Down have forwarded to us samples and description of okonite wire, for which they are sole agents in this country. The insulation is practically all vulcanised rubber, treated with a compound which causes it to be absolutely without that porosity and pinholing which is almost always present in rubber compounds. It will stand a large amount of rough treatment such as wires seldom require to undergo, and keeps its elasticity even when subject to weather influences of alternate moisture and dryness. If it were not for chance of mechanical injury it could be put underground in an ordinary excavated trench, without using earthenware or other piping, and keep its insulation. This is a very important point, as many wires may test well for short periods and then go entirely wrong. As an instance of severe work, it is mentioned that the wires in Chicago are run underground in the sewers on brackets coming out from the wall with ordinary common glass insulators. When the Chicago river is in flood, the wires, insulators, etc., are completely under water; and in the ordinary way they are damp, while at midsummer they are dry. The E.M.F. here is that of 35 light and 50 light Thomson-Houston machines, and there are about 400,000ft. of this wire in use to run about 2,000 lights. It has been found equal to guttapercha for ordinary underwater work, and several small cables are made with it instead of guttapercha, which it bids fair to supersede. The Thomson-Houston Company state that in their experience it is not surpassed by anything

they ever heard of, and they use it very extensively. Messrs. Laing, Wharton, and Down mention that it is rather dearer than any other wire, but they have found the quality and lasting properties so good that they have acquired the control of it so as to use it for their own purposes. The multiple and single telegraph and telephone cables can be used underground in ordinary troughing and for tunnel sides. The ordinary quality of this wire is guaranteed 1,000 megohms, and really is double this, and even the flexible silk-covered cord has the same insulation resistance.

Overhead Electric Wires in Glasgow.—The following communication from Firemaster Paterson to the Watching and Lighting Committee was read at the meeting of the Glasgow Town Council: "I deem it my duty to direct your attention to the rapid spread of overhead electric light cables and wires in the centre of the city, and the great danger to the men, horses, and plant of this department arising from this cause. When the overhead cables connecting the General Post Office with the electric light premises in Miller-street were erected, and the connections to the Royal Exchange and other buildings were made, I did not raise the question, as it was then believed that this was only a temporary arrangement, and that the whole would soon be laid underground. I now find that cables have been or are being run over nearly every block in the centre of the city and across all our principal streets. I am not aware under what authority or control these lines are being erected, or if there is any municipal supervision whatever. It appears to me that there is none, and that the contractors are arranging terms with proprietors and putting up poles and cables to suit their own convenience, independent of any consideration for public safety. I do not desire to create any unnecessary panic or alarm in regard to overhead electric lighting wires; but within the past few months there have been numerous deaths from this cause (in America), and the men in this department are specially liable to risk, as our work on roofs has frequently to be carried on during the night. The danger of fire is also very much increased by any defect in the installation or by the breaking of a wire or cable. Chicago and some other American cities having extensive systems of electric lighting were compelled in the interests of public safety to remove all overhead wires, and it does appear strange that while other cities are taking down these wires Glasgow should be allowing them to be put up, and an interest created that may be troublesome to deal with. Without going any further into details, I am of opinion that serious consideration should be given to this subject, as it is one that may involve the Police Board in grave responsibility and expense." Mr. Gray said the question of overhead wires noticed in that communication had been before the Watching and Lighting Committee; and considering the tendency to extension at the present time, it was thought better to send it forward to the Police Board. It was thought that something should be done at once, and he therefore proposed that as it affected other interests a special committee, consisting of the conveners and sub-conveners of the various committees of the Police Board, with the Lord Provost as chairman, should be appointed to take it into consideration. Mr. Primrose seconded the motion. Bailie James Martin said he was almost certain that the Police Board had no power to interfere with the overhead wires. The town clerk said that enquiry would be made into the matter. The motion was then agreed to.

THE SMITHFIELD SHOW.

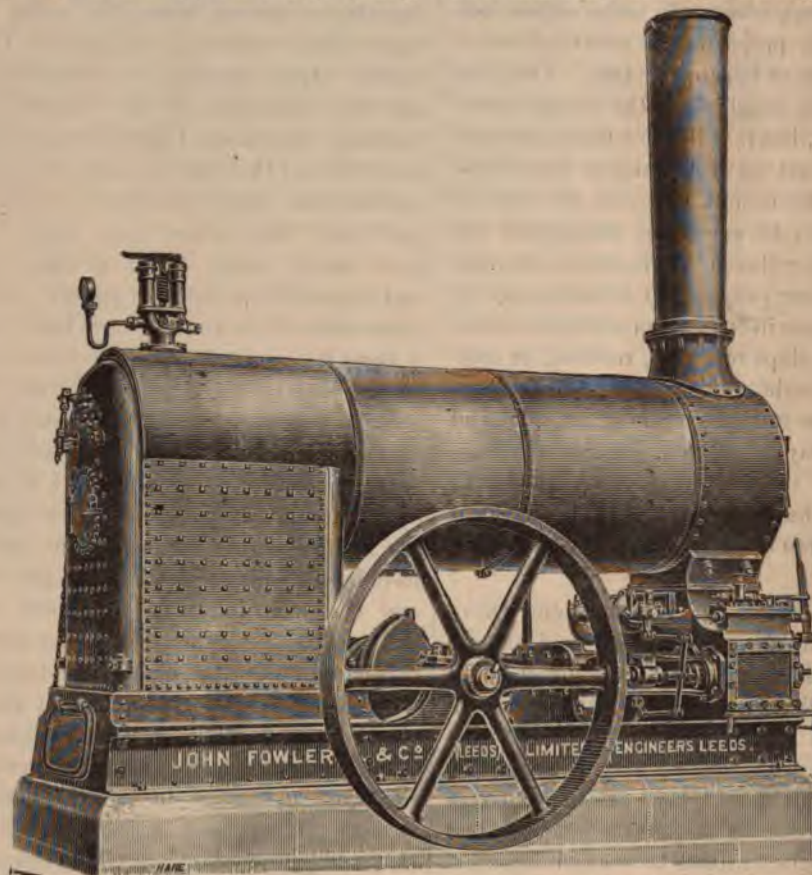
One of the signs of the times is that engine-builders who exhibit at the various agricultural shows held throughout the year, as each succeeding show comes round, exhibit engines "specially" adapted for electric light work. Although the Smithfield Show is principally devoted to fat cattle, and the secondary portion to agricultural implements, it is noticed that several of the engine-builders follow the course we have indicated, and those who do not make a point of such exhibit are eager to tell you that while their engines as shown are designed more especially for farm and haulage work, they have engines which cannot be beaten for electric lighting work. Some years ago one eminent firm—Marshalls and Sons—seemed to have almost a monopoly of engines for electric lighting work, but nowadays they seem to have gone back, and other makers are rapidly coming to the front. Thus at Windsor, Messrs. John Fowler and Co., of Leeds, exhibited the engines made for the electric lighting at Colonel North's mansion at Eltham. At Smithfield, stand No. 7, they

trical work. This engine is shown in the cut herewith. The main frame is in one casting, of the circular hollow type, which, while lighter than the ordinary cast-iron foundation-plate, is considerably stronger, being in a direct line with the throw or thrust of the engine.



Messrs. Ransomes' Sims' and Jefferies' Long-Stroke Stationary Engine.

The crankshaft is of steel or best hammered scrap iron; the crank is of the disc type, accurately turned, bored, and balanced, and securely fixed to crankshaft; the crankpin is of steel, rivetted into the disc. But it is immaterial to enter into exact details, as the engines are of the usual type



Messrs. John Fowler and Co.'s 8-h.p. Semi-Portable Engine.

exhibit an 8 h.p. semi-portable engine, described as "specially constructed for electric lighting." This engine, which is illustrated herewith, is fitted with Hartnell's patent automatic expansion gear on both cylinders. As usually constructed, engines of this type have automatic gear only on the high-pressure cylinder; but it is essential that the automatic gear should act on both cylinders, if the power given off by each cylinder is to be equal under varying loads. This engine is said to be not only economical, but extremely well governed. It is incapable of exceeding by more than one or two per cent. its mean speed when the load is suddenly removed, and will not fall below the mean speed by a greater amount when the whole load is suddenly thrown on. In practice a small fraction of one per cent. variation of speed at once begins to alter the degree of expansion, a result quite unattainable in ordinary governing, which is absolutely necessary in electric light engines. Messrs. Fowler exhibit several other engines besides the one referred to, all suitable for the object for which they are designed.

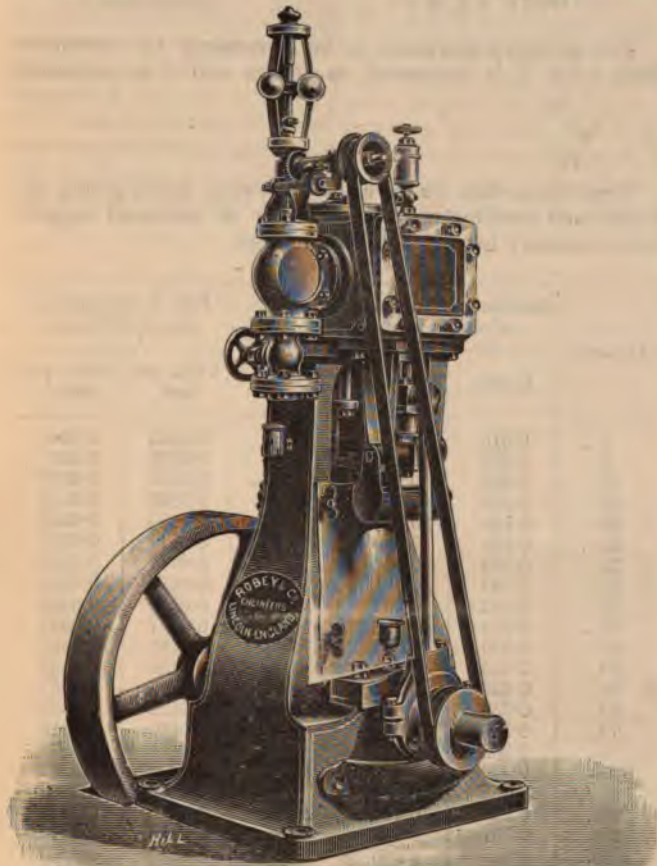
Messrs. Ransomes, Sims, and Jefferies exhibit, among other engines, a long stroke stationary engine, suitable for elec-

constructed by this firm. The parts have been carefully apportioned, and the materials are selected as is found best for the wear of the parts.

Messrs. Robey and Co. exhibit their vertical high-speed engine, as shown in the accompanying illustration. This engine is intended to be coupled direct to the dynamo, as shown, and is especially serviceable when space is important as on board ship. In fact, the engine has been specially designed for ship lighting, but it is equally suitable for any other purpose where great power is required in a small space. It is designed to work with a high steam pressure, and may be arranged to run at various speeds as may be found most suitable for the work it has to do. All the wearing parts have very large surfaces, and it is fitted up with means for self-lubrication, so that it may be run continuously without any risk of heated bearings. While every part of it is thoroughly well lubricated, it is so arranged that no oil is wasted. When used for electric lighting it is mounted on a cast-iron base-plate, the other end of which carries the dynamo, as shown in the illustration. The base-plate is provided with lugs and adjusting screws, so that the driving belt can be tightened without stopping the machinery. The engine

is perfectly balanced, so as to run at a high speed without excessive wear, and the whole forms a strong, durable, and compact motor, which can be thoroughly relied upon to work economically and safely during long runs without giving trouble.

Besides the engine above referred to Messrs. Robey exhibit one of their well-known compound Robey semi-fixed engines, which is fitted with their patent automatic governor and link expansion gear, by means of which the utmost economy in steam is produced with perfect regularity in speed. It is said that a series of carefully-conducted tests show that the improved compound engines, as made by Robey and Co., will work with a consumption of less than 2lb. of Welsh coal per horse-power per hour when developing two and a half times their nominal power. Besides these are several other engines of this firm's well-known make.



Messrs. Robey and Co.'s Vertical High speed Engine.

It is not necessary to refer to the workmanship of the well-known firms whose exhibits are mentioned here—that will be sure to be first class.

ON THE HEATING OF CONDUCTORS BY ELECTRIC CURRENTS.—II.

BY A. E. KENNELLY.

The accompanying diagram, Fig. 4, shows the curves obtained by freely connecting the plotted observations resulting from the whole series of panel measurements. The ordinates represent the temperature elevations, and the abscissas are the current strengths to which those temperature elevations are due. Of the three connected variables, diameter, current strength and rise of temperature, this figure most clearly indicates the relation between temperature and current, while the influence of diameter may be deferred for the moment. It is seen that, generally speaking, the temperature elevation varies as the square of the current strength for any given wire. This would be, perhaps, rigorously true if the resistance of the wire did not increase with temperature, if the conductivity of the panel

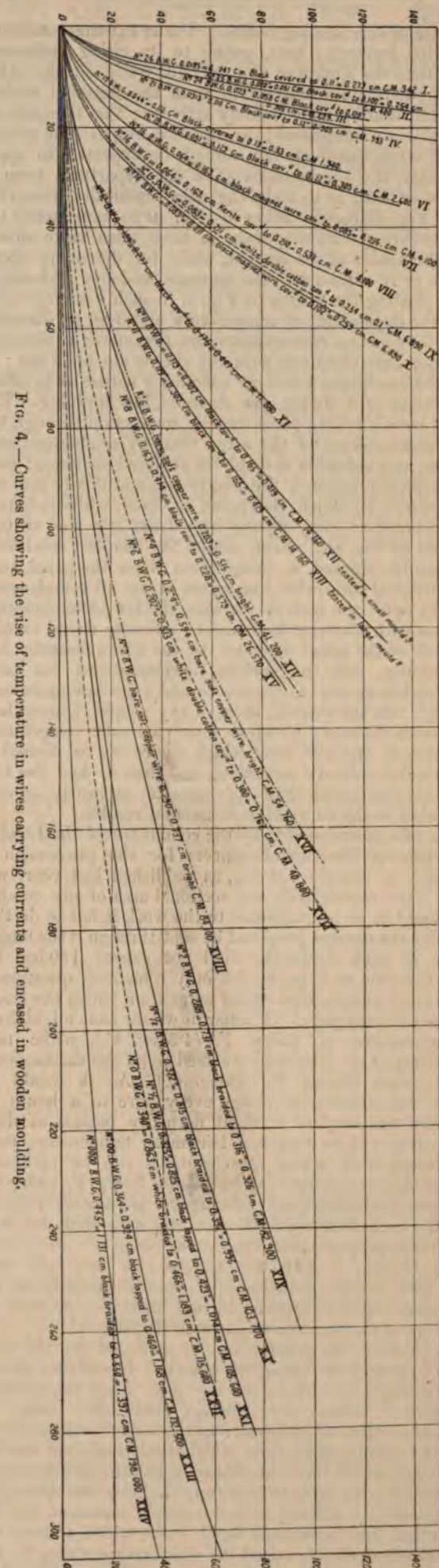


Fig. 4.—Curves showing the rise of temperature in wires carrying currents and encased in wooden moulding.

remained constant, if the space between the wire and the panel walls were filled with solid material, and finally if the exterior surface of the panel were maintained at the tem-

perature of surrounding bodies. Under existing conditions the wire generates heat, owing to its rising resistance, faster than the square of the current, while, on the other hand, radiation and convection from the external surface are more than proportionately active as the temperature rises, the two deviations thus counteracting to some extent, so that while the above law cannot be expected to apply accurately, the observations show the departures from it are not so great as to make the rule practically unserviceable. For diameters below 0.10in. (0.25 centimetre) the temperature elevation appears to have risen more slowly than the square of the current, while for diameters above 0.30in. (0.76 centimetre) the opposite tendency is shown.

On plotting the results of Fig. 4. in such a manner as to elicit the dependence of temperature elevation on diameter alone for constant current strengths, the curves so obtained have not been identified with any simple algebraic law; in fact, the conditions are of so complex a nature as to afford little hope of a simple, yet rigorous, law applying. The loss of heat is taking place first by conduction through the insulating covering of the wire; then by conduction, convection, and radiation through the enclosed air space; next by conduction through the woodwork, and finally into the floor or wall to which the panel is fixed, while radiation and convection carry off the heat from the free surface exposed to the air. Even under the simplest conditions that can be imposed in imagination upon the panel, such as cylindrical form with free access of air all round, and a tight fit upon the wire at the axis, the law of temperature increase with diameter for constant currents would involve the ratio of the panel diameter to the wire's diameter logarithmically, and the various dissymmetrical but practical conditions can only serve to make the law more complicated. In the absence, then, of any simple rigorous law, it becomes necessary to select some particular temperature elevation as the safe limit which a wire can be allowed to reach under ordinary conditions, and then to find the best empirical rule which shall approximate as nearly as may be needed to the curve of experimental results.

The rule recommended by the committee of the London Institution of Electrical Engineers for the prevention of fire risks in electric lighting, as published last year, was that: "The conductivity and sectional area of any conductor should be so proportioned to the work it has to do that if double the current proposed be sent through it the temperature of such conductor shall not exceed 150deg. F." With this rule as a guide, the only remaining question is the normal temperature of the wires from which the rise is assumed to take place. A cellar in winter time might have a temperature of 40deg. F. (4.5deg. C.), while near the ceiling of an artificially-warmed room the thermometer might reach 100deg. F. (38deg. C.). As it would be out of the question to design every wire in a house for the exact temperature it might normally possess at different portions of its length, a fair mean temperature must be selected from which all elevations can be reckoned. This mean temperature may be taken at 75deg. F. (24deg. C.) This being admitted, the rule above mentioned requires that the temperature elevation of any wire shall not, with double the proposed current, exceed 75deg. F.—i.e., reach above 150deg. F. (41.7deg. C.), and it has been seen that this is, for practical purposes, equivalent to the statement that the proposed current shall not produce an elevation of one-fourth that amount (10.4deg. C.).

Fig. 5 shows the general results arranged for the purpose of directly indicating the observed dependence of current strength and diameter for any given temperature elevation. Taking for granted that the 10deg. C. elevation is that which prescribes the safety limit as above, then the empirical formula which shall represent the 10-degree curve will form the rule by which the safe diameters of panelled wires may be determined. For the 10deg. C. curve itself it is difficult to find a simple equation, but for the broken line curve near it, — — —, which follows the current whose double raised the temperature 40deg. C., the equation:

Limiting current in amperes = 560 (diameter of wire in inches)^{3/2}, is seen to be closely applicable except for very small wires, the curve — — —, in conjunction, being the strict locus of this equation.

This formula makes the small wires rather larger than experiment has shown they need be, but it will be seen that even then they are much smaller than the Board of Trade rule requires.

The following are, then, the proposed formulæ for determining the limiting safe currents and diameters for insulated copper wires in wooden panels:

$$\begin{aligned} C &= 560 & d^{3/2}, \text{ if } d \text{ be expressed in inches;} \\ &= 0.01775 & d^{3/2}, \text{ if } d \text{ " " " " mils;} \\ &= 138 & d^{3/2}, \text{ if } d \text{ " " " " centimetres;} \\ &= 4.375 & d^{3/2}, \text{ if } d \text{ " " " " millimetres.} \end{aligned}$$

And reciprocally,

$$\begin{aligned} d &= 0.0147 C^{2/3}, \text{ if } d \text{ be expressed in inches;} \\ &= 14.7 & C^{2/3}, \text{ if } d \text{ " " " " mils;} \\ &= 0.0374 C^{2/3}, \text{ if } d \text{ " " " " centimetres;} \\ &= 0.374 C^{2/3}, \text{ if } d \text{ " " " " millimetres;} \end{aligned}$$

For ordinary purposes it is convenient to remember that when d is expressed in inches and C in amperes,

$$d = \frac{\sqrt{C^2}}{70}$$

From these data we have the following table, giving in inches and centimetres the diameter of insulated copper wire necessary for any specified current:

Amperes.	Minimum safe diameter of copper wire.		Circular mils per ampere.	Fall of potential in wire at full load.	
	Inches.	Cms.		Volts per foot.	Volts per metre.
1.....	0.015	0.038	225	0.0503	0.165
5.....	0.043	0.109	370	0.0305	0.100
10....	0.069	0.175	480	0.0237	0.0777
15.....	0.090	0.229	540	0.0208	0.0681
20.....	0.109	0.277	590	0.0189	0.0621
25.....	0.126	0.320	640	0.0177	0.0581
30.....	0.142	0.361	670	0.0167	0.0548
35.....	0.158	0.401	710	0.0158	0.0518
40.....	0.172	0.437	740	0.0152	0.0499
45.....	0.186	0.472	770	0.0147	0.0481
50.....	0.200	0.508	800	0.0141	0.0461
55.....	0.213	0.541	825	0.0136	0.0447
60.....	0.225	0.572	845	0.0133	0.0437
65.....	0.238	0.605	870	0.0129	0.0423
70.....	0.250	0.635	890	0.0126	0.0413
75....	0.262	0.655	915	0.0123	0.0403
80.....	0.274	0.696	940	0.0120	0.0393
85....	0.285	0.724	960	0.0118	0.0386
90.....	0.296	0.752	970	0.0116	0.0379
95.....	0.307	0.780	990	0.0113	0.0372
100....	0.318	0.808	1010	0.0111	0.0365
110....	0.339	0.861	1040	0.0108	0.0353
120....	0.358	0.909	1070	0.0105	0.0346
130....	0.377	0.958	1090	0.0103	0.0337
140....	0.396	1.01	1120	0.0099	0.0327
150....	0.415	1.05	1150	0.00975	0.0320
175....	0.461	1.17	1210	0.00929	0.0305
200....	0.504	1.28	1270	0.00887	0.0291
225....	0.545	1.38	1320	0.00853	0.0280
250....	0.585	1.49	1370	0.00817	0.0268
275....	0.623	1.58	1410	0.00798	0.0262
300....	0.660	1.68	1450	0.00771	0.0253
325....	0.697	1.77	1490	0.00753	0.0247
350....	0.732	1.86	1530	0.00734	0.0241
375....	0.766	1.95	1570	0.00716	0.0235
400....	0.800	2.03	1600	0.00714	0.0231
425....	0.832	2.11	1630	0.00692	0.0227
450....	0.865	2.20	1660	0.00674	0.0221
475....	0.897	2.28	1690	0.00665	0.0218
500....	0.928	2.36	1720	0.00652	0.0214
550....	0.988	2.51	1775	0.00634	0.0208
600....	1.049	2.66	1840	0.00616	0.0202
700....	1.16	2.95	1920	0.00585	0.0192
800....	1.27	3.23	2020	0.00558	0.0183
900....	1.37	3.48	2080	0.00539	0.0177
1000....	1.47	3.73	2160	0.00521	0.0171

DATA: Insulated house wires carrying continuous currents, and encased in wooden panelling. Copper resistivity: 1.650 microhms at 0deg. C. = 1.870 microhms at 34deg. C. assumed temperature of full load. Conductivity allowed, 98 per cent.

This table shows that whatever temperature elevation might be adopted as the safety limit, the principle of fixing upon the diameters of conductors by allowing a certain number of amperes to the square inch, or a certain number

of circular mils to the ampere, can only be very imperfect unless a sliding scale be arranged. Thus the diameter of wire which coincides with the Board of Trade limit of 1,000 amperes per square inch is 0.504in. for 200 amperes. According to the table, that rule would not be safe for wires above that diameter, while for wires beneath that diameter it would, in respect to safety, be very uneconomical. Thus to carry 400 amperes at 1,000 amperes per square inch requires 508,000 circular mils, or a diameter of 0.713in., while the table indicates 0.800in., and, on the other hand, to carry 40 amperes the same rule calls for 0.225in., the table showing only 0.172in. to be necessary.

For the same reason, when the space occupied by the wire is no object there is always an economical limit to the size of the main in any house installation, for if the fall of potential permissible in them reduces their selection to pure considerations of safety, then it will always be more economical to subdivide the conductors for heavy currents. For example, if 500 amperes have to be carried at full load, the table indicates a main of 0.928in. (2.36 centimetres) in diameter. But by taking two equal mains, each carrying 250 amperes, their diameters will be 0.585in. (1.49 centimetres), and the weight of copper will be reduced rather more than 20 per cent., and in all cases whenever 20 per cent. of the

temperature elevation is seen to have been about 30 per cent. lower than that obtained with a wire of the same diameter, but only covered to a thickness of 0.011in. (0.028 cm), No. VII.

As regards the surface-nature of the insulating material, curves Nos. IX. and X. represent the behaviour of two wires whose diameters and thickness of insulation were practically equal. No. IX. was double-covered with white cotton; No. X. single-covered with blackened cotton. All the ordinary insulated house wires were covered at the Edison machine works, Schenectady, N.Y., with cotton soaked in a special insulating liquid. The temperature elevation of the latter was about 4 per cent. the lower, and while it is possible that this difference may have been due to the superior radiating power of the black coating, it is not sufficiently marked to be more than a possibility.

Curves Nos. XII. and XIII. show the temperature elevations of the same length of wire first in the smaller paneling and then in the larger. In the latter case there is a cooling effect visible, amounting to 10 per cent.

The conclusion rests that, while the exact temperature elevations of a panelled wire depends upon a variety of factors, it is capable of being fairly estimated from the average of a number of experiments under actual condi-

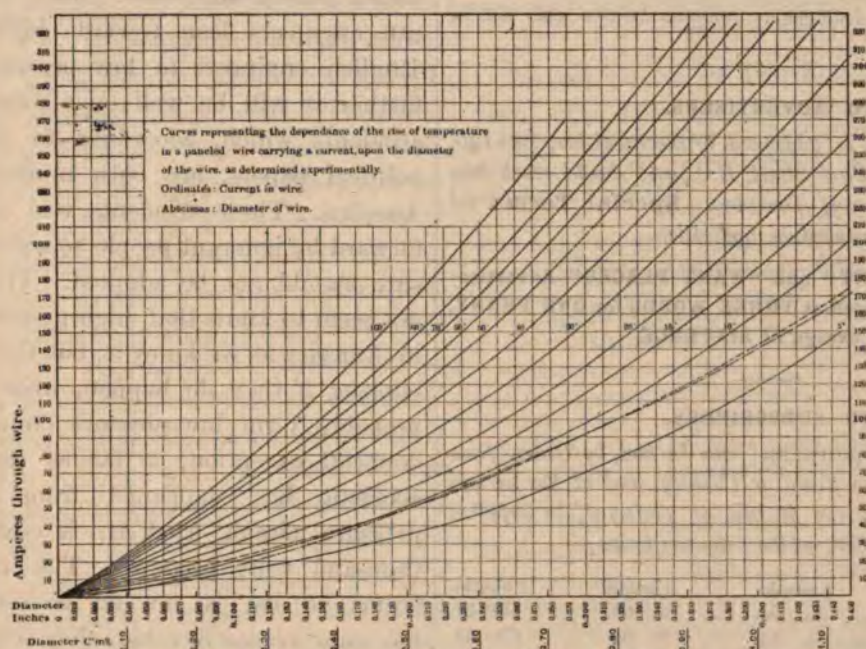


FIG. 5.—Curves representing the dependence of the rise of temperature in wires, upon their diameter.

cost of copper necessary for one main will more than cover the expense of another insulating covering and paneling for the second wire, there being no independent objections, it will be economical to divide the conductor.

This remark is of course not merely a deduction from the table, nor in any way implicated with the limiting temperatures on which it is based, but is founded on the fact that when a wire's diameter is doubled, although it takes twice as strong a current to develop the same heat as before per unit volume, there will be four times as much total heat and only twice as much surface through which that heat has to find egress.

Referring to the general curve sheet, certain deductions may be made from it concerning the effect of the nature and thickness of insulating covering, and also the influence of the panel dimensions.

The evidence is distinct that with all the wires tested, and which had the usual thickness of insulating covering [about 0.050in. (0.13 centimetre) for the small and large wires, with about 0.035in. (0.09 centimetre) for the intermediate sizes], the effect of the insulation covering was to cool the wire. Thus curves Nos. XIV., XVI., and XVIII., Fig. 4, represent the observations on bare copper wires, and show that their temperature elevations were fully 30 per cent. in excess of that found in covered wires of equal diameter and load. Again curve No. VIII. refers to a kerite wire whose coating was 0.073 (0.185cm.) inch thick. Its

tions, and care has been taken to obtain these measurements under as nearly practical conditions as possible. The mean conductivity of the wires was about 99 per cent.—that is to say, a mean resistivity of 1,640 absolute legal units. The temperature coefficient has been taken at $1 + 0.00388 t$, t being the elevation in degrees centigrade.

In applying the rule for safety limitations as given by the table, insulated wires are, of course, to be understood, and no particular thickness or quality of insulation need then be specified. For although extra thick insulating covering cools the wire, it would not be desirable to render it specially thick merely with that object in view. Also each wire should have its own groove, or, if several wires are in the same channel, the total area and surface of the woodwork should be correspondingly large. Finally, the paneling should be run as far as possible through places not exposed to an abnormally high temperature.—*Electrical World*.

Argentine Cable.—The Argentine Senate has approved the Bill for granting a guarantee to Messrs. Bieckert and Co. on the capital to be expended in laying a new telegraphic cable to Europe. The working expenses are fixed at 100,000dols. gold per annum, and the cable must transmit 18 words a minute; official telegrams to be sent gratis.

THE ELECTRICAL ENGINEER.

[Published every Friday.]

Price Threepence ; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices :

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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IMPORTANT NOTICE.

We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No paper that we know ever refuses Subscribers or Advertisers. Nor do we ; in fact, we invite them, believing that they will get full value for their money.

Specimen copies of the paper will be sent on request.

HIGH OR LOW PRESSURE.

It is often said that humanity would be in a very unsatisfactory condition if every man thought alike. A difference of opinion is like a tonic, and acts as an incentive to really learn all about the question. In the distribution of electricity, Edison, who may be termed the Hercules of American electrical engineering, has gone, without question, to the side of those who advocate a low-pressure distribution, while Ferranti, the Archimedes of England, has as emphatically gone with those who advocate the high-pressure system. Both these men are answerable for the largest existing installations—Edison in New York, Ferranti at the Grosvenor Gallery—though the latter has an installation to be worked from Deptford of much larger size still, almost ready for what may be termed ordinary work. Neither in America nor in England do these great advocates of rival systems obtain general allegiance. Many well-known American engineers lean towards high pressure, many English engineers to low pressure. Before going further it will be well once more to refer to the accidents which, according to telegrams in the political papers, are both numerous and fatal in America. These accidents, real or unreal, are put forward by ignorant people as a proof why high pressure should not be adopted. These advocates do not seem to know that high pressure does not exist in America as we know it, but that these accidents happen, if they do happen, upon what we should probably term low-pressure circuits. With one doubtful exception, so far as we know, no fatal accident has happened from any really high-pressure circuit—that is, a circuit of, say, two thousand volts pressure. The reason of this, it seems to us, is not far to seek. In America, for some reason or other, they seem to deem their circuits safe, and are very lax in using protected wires. As often as not bare wires are used, and this can only arise, as we say, from a false sense of security, from a wilful neglect of ordinary precaution, or from insensate rage for cheapness. At any rate, the facts are as we have said. In America there are accidents with comparatively low pressure, in England none with very high pressure. Say five hundred volts is the limit of low pressure. Ferranti has long distributed under two thousand pressure, and now contemplates in his mains ten thousand volts pressure. These, then, are the rival systems, and the results so far as accidents are concerned. The conclusion on this point is that, whether owing to the greater precautions or the better insulation used, the safer system is the high-pressure system as used in England. The question of safety or danger is not the one that will prevail to place one system over the other. They can both be made safe. In the long run only one question will have weight, and that is one affecting £ s. d. Of course, though

we vulgarly talk about current, or rather we talk so because our masters so taught us and so teach, yet no piece of apparatus was ever made that generated "current." In any circuit, that matter (be it ether or whatever it be)—that is, electricity—is there in constant quantity. We construct a piece of apparatus to make a difference of pressure or potential to create an electromotive force, or whatever we like to term it. That pressure drives a greater or less current through a given section of the conductor in a given time, according as it is greater or less. Now the apparatus required to create a high pressure is different to that required to create a low one. Both initial cost and cost of maintenance differ, but even this is not the crucial question which brings conviction. It is rather to be found in the initial cost of mains, as most of our readers are aware, and those converted to a high-pressure system are generally converted because the capital outlay for distribution seems to be so much less. In the high-pressure system, to the initial cost of mains should be added the cost of the apparatus for conversion from the high sending to the low working pressure. This is not all; the cost of maintenance of this apparatus must also be added, so that the question is not so simple as it appears. Add to these considerations that the low pressure is generally a constant-current system and the high pressure is an alternating system, and other complications arise. The constant current can at once be utilised for distribution of power, the alternating cannot, though apparatus is promised that it is said will enable it to be so used. Thus the one system is calculated to at once increase revenue over and above the other. This again brings the real value of the two systems closer together, even in the eyes of those determined to see good only in the one and bad only in the other. The uncertainty of the real value of either system is so great that we feel disposed to say it cannot at this stage of operations be determined. Time alone will prove the flexibility of each system, time alone will give figures relating to capital, maintenance, and revenue accounts; and till these are known with absolute certainty all the abstract arguments of Edison, on the one hand, or any supporter of the high-pressure system, on the other, are so much wasted breath.

Nothing is more certain than that both systems are workable systems, and nothing is more certain than unless alternate-current motors can be designed and constructed the constant current must prevail, though whether the pressure is ultimately to be high or low we cannot say. Perhaps both systems will survive, and be utilised according to the circumstances surrounding each individual case. In regard to this controversy we should like to be able to obtain accurate data as to cost, but firms and companies hesitate to make public the figures they obtain.

The initial cost of the New York installation was out of all proportion to what the cost of a similar installation would be now; so has been the case at Deptford. Thus, the figures of these, if we had them, would be misleading. The greater initial cost is followed also by a greater cost of maintenance, for the dynamos as originally put down at New York are far from as perfect as those made to-day, and without doubt Mr. Ferranti's dynamos will not be perfect. Correct figures, then, cannot be forthcoming, and the taking of such figures as these are, making deductions here or there for increased efficiency, leads to no certain end. The Americans graphically describe the uncertain politician as a mugwump, and no doubt they will coin as euphonious a term to express the uncertain electrician. What will it be?

CORRESPONDENCE.

THE REV. STOPFORD BROOKE AND THE SILVERTOWN STRIKE.

TO THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—The Rev. Stopford Brooke having preached recently on this subject at Bedford Chapel, we enclose for publication our correspondence with reference to his sermon.—Yours, etc.

WM. J. TYLER, secretary.

The India Rubber, Gutta Percha, and Telegraphic Works Company, 106, Cannon-street, E.C., Dec. 10.

"India Rubber, Gutta Percha, and Telegraph Works Company, 106, Cannon-street, E.C., Dec. 3.

"Sir,—In yesterday's *Star*, of which I enclose a copy, you are reported to have made the following statements publicly to your congregation:

"1. That this company made £160,000 profit last year.
"2. That our shareholders are receiving a dividend of 15 per cent.

"3. That if lads working in a temperature of 120deg. at our factory take half an hour's wait before going into a cold room they are discharged at the end of the week without cause assigned.

"4. That girls are liable to be kept idle all day at our factory if work is not ready for them, and then are turned off without pay for the idle day if they go or ask to go home, and that their time is seized on, but not paid for.

"5. That a poor widow with a large family who earns 14s. a week at our works, and one week by a desperate spurt 14s. 6d., was docked ½d. an hour because the manager thought she had been underworking.

"6. That old hands at our works had been threatened with dismissal, and when they begged leave to stay they were allowed to do so at ½d. less an hour.

"Assuming that you are correctly reported, I am directed to ask you upon what evidence you made these statements, all of which are untrue, and on the strength of which you obtained money from your hearers, and to request a reply in writing without delay.—I am, sir, your obedient servant,

WM. J. TYLER, secretary.

"The Rev. Stopford A. Brooke, M.A., 1, Manchester-square, W."

"India Rubber, Gutta Percha, and Telegraph Works Company, 106, Cannon-street, E.C., Dec. 6.

"Sir,—In our letter of the 3rd inst. we called your attention to six untrue statements to which you were reported to have given currency from your pulpit.

"Yesterday we received a letter from your solicitors, which we refuse to accept as a reply. Our solicitors will correspond with them if occasion should arise, but for the present we have to do with you only.

"The substantial accuracy of the *Star's* report of your sermon seems to us sufficiently proved by the similar reports published by at least three other newspapers—the *Daily News*, the *Pall Mall Gazette*, and the *Echo*. Have you made a public disavowal of any of these reports? No. Are you reserving that disavowal for your congregation, whom you so grossly misled into parting with their money? We shall see.

"Besides the six cases to which we called your attention, you appear to have thought it consistent with your responsibility as a Christian minister to denounce us for not accepting arbitration (as if, forsooth, we had no choice but to permit outsiders or volunteers to interfere), to assert that we refused to see those who offered to arbitrate (which is untrue, for we saw all who called and told them we could not agree to their proposal), to say that our workmen were locked out (which, as they very well know, is untrue), and generally to describe our system as one of cruel injustice.

"We charge you with having borne false witness against us in these ten specified instances. If you were misreported, you should at least have had the manliness to tell us what you did say under these heads, for we infer from your lawyers' letter that you preached from manuscript. If the reports are substantially true, you stand convicted of having used your pulpit for the circulation of gross slanders concocted from hearsay, or, at best, *ex parte* statements, which you ought to have verified or disproved by enquiry at this office.

"In short, you have traduced recklessly and without scruple those who are as honourable and humane as yourself, and when brought to book, instead of frankly confessing your mistake and apologising, you seek to shelter yourself behind your lawyers and throw the blame on the reporters. Moreover, having so behaved, you, of all men, presume to say who are gentlemen and who are not. To judge by your own conduct, you are not a good authority on this point.

"It may interest you to learn that some of your gentlemen have taken to kicking and maiming their fellow workmen and workwomen who did not agree with them on the labour question. Perhaps they did this by way of commentary on your estimate of them. One of their latest victims now lies dangerously ill in hospital.

"One more baseless charge, by the way, you bring against us—that we have allowed statements in the press similar to your own to pass uncontradicted. If this were true it would not help you; but you know, or ought to know, and probably your informants did know, that on three separate occasions during the strike we have addressed a letter for publication to about 100 newspapers, giving a clear and irrefutable statement of the main facts. We will add, however, that, considering the channel through which the charges against us in the press have chiefly been disseminated, we should have been fully justified in ignoring them.

"We venture to suggest to you a thorough reconsideration of this, the latest question on which you have presumed to dogmatise. Whether you will be led in some way or other to make amends remains to be seen.

"We reserve the right to publish this correspondence.

"I am, sir, yours obediently,

"WM. J. TYLER, secretary.

"The Rev. Stopford A. Brooke, M.A.,
1, Manchester-square, W."

"1, Manchester-square, W., December 8.

"Sir,—The tone of your letter of the 6th inst. is such that I might well leave it unnoticed, but I prefer to define in a few words my position in the question that has arisen between us, and to point out how, in my opinion, some good result may yet be attained.

"As you are aware, the statements made by me on Sunday, the 1st of this month, were the repetition of statements made by your company's former workpeople to friends of mine, on whose capacity and judgment I have every reason to rely, and in making them I explained fully the source from which they were derived. You now select a few of these statements to give them a categorical denial, and then call upon me to withdraw and apologise,

and you appear to think that I am entitled to censure for having accepted the information given to my friends by the workpeople. But I do not see why I should accept your categorical denial of statements made by persons directly concerned in the matters under discussion, when your own information on most of these matters must necessarily be second hand.

"You appear to think that the managers of your company have no responsibility to outside opinion. I hold a contrary view, and I spoke strongly of the conduct of your directors in refusing arbitration. This refusal you apparently do not deny, but only seek to minimise the discourtesy which marked the rejection of the proposal—a discourtesy, I may add, which was certainly not an encouragement to a stranger who might interest himself in the dispute to make application to your office, as you now suggest I ought to have done. I trust, however, your directors may yet see their way to accept the proposed arbitration, and I am quite willing to put all the information given to me into the hands of any arbitrators selected, with the view of its being tested, and if in any point it turns out to be unfounded, I shall at once give publicity to the refutation of charges made by your workpeople now on strike—charges which I am glad to see you feel to be a reproach.

"I must decline to continue this correspondence, but if you think that I incurred legal responsibility to your directors my solicitors will, of course, attend to any communications you may send them.

"Any publication of our correspondence, whether by you or me, will of course include this letter.

"I am, sir, your obedient servant,

"STOPFORD A. BROOKE.

"The Secretary, India Rubber, etc., Company,
106, Cannon-street, E.C."

"India Rubber, Gutta Percha, and Telegraph Works
Company, 106, Cannon-street, E.C., Dec. 10.

"Sir,—We have received your letter of the 8th inst., and wish, for your own credit's sake, you had acted differently. Surely it was incumbent on you either to withdraw your charges, or to substantiate them.

"Instead of doing this, you add another to the long list by accusing us of discourtesy to Messrs. Buxton, Webster, and others. You insinuate, too, that we found it convenient to ignore some of your imputations, whereas you well know that we traversed every statement published in the fullest available report of your sermon, and then challenged you to produce your evidence.

"Having thus aggravated your offence against us, you indicate our legal remedy, and, forgetting the unsparing abuse of which your sermon was full, wince under the naturally indignant tone of our letter. Moreover, by a curious process of reasoning, you find you can accept assertions to our discredit, but not our denials.

"We take leave of you with a feeling of great regret that, having gone so far astray, you shrink from making admission and atonement.

"I am, sir, yours obediently,

"WM. J. TYLER, secretary.

"The Rev. Stopford A. Brooke, M.A.,
1, Manchester-square, W."

INSULATED WIRE.

TO THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—Mr. W. Fowler, chairman of the Fowler-Waring Cable Company, Limited, is reported to have stated at that company's statutory meeting on the 6th instant: "We found a place on the Thames at North Woolwich, formerly used by Mr. Henley, a great maker of cables, but long since deceased." As this statement may be taken to imply that the late Mr. Henley ceased to manufacture cables after giving up the works Mr. Fowler referred to, I beg to state that Mr. Henley forthwith adapted adjoining works, and fitted them with the most modern and approved machinery for cable making, and that these latter works, and all Mr. Henley's patents connected with submarine and other cables, were in 1880 sold to our company, Mr. Henley continuing the management until his decease in 1882.

A large proportion of your readers are, of course, aware

of the continued activity of these works, as amongst your readers are no doubt included most of our customers, but to avoid any likelihood of error we shall be glad if you will kindly insert this letter in your next issue.

As a matter of fact, since Mr. Henley's decease the company has reaped the benefit of the great development of electrical industries, and the business has tripled or quadrupled since 1882, many tons of copper being now used per week for electric light conductors alone, in addition to which we have considerable employment in making telephone, telegraph, and other wires and cables, our out-turn of submarine telegraph cable during the present year having exceeded 1,000 miles.—Yours, etc.,

G. SUTTON, manager and secretary.

W. T. Henley's Telegraph Works
Company, Limited.

REFLECTORS.

TO THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—With reference to your very kind notice of the American reflector shades, which I am introducing, in your issue of yesterday, it occurs to me that readers of the same may conclude that the whole of the fitting illustrated is an American importation. As a matter of fact, the glass shade is the only part which I import, all the fittings and holders for the same being entirely of my own design and manufacture.

I believe, also, that I am right in saying that the idea of making fittings to hold several of the shades at various angles, and so obtain a general light, is my own, and that it has not been tried in America.

The insertion of this in your next issue will much oblige.
Yours, etc., R. L. B. RATHBONE.

73, Bold-street, Liverpool, Dec. 7.

NEW YORK NOTES.

(FROM OUR SPECIAL CORRESPONDENT.)

A Recent Accident Resuscitated to Point a Moral.
Where the "Daily News" Correspondent got his Information.
The Grand Jury and the Wire Question.
The Subway Situation Reviewed.
Dangerous Practices Condemned.
The Board of Electrical Control in Hot Water Again.
Comment on the Institution Dinner.
A New Call.—Is it a "Sell"?
New Cable Connection.

NEW YORK, November 29, 1889.

I see that considerable interest has been aroused on your side of the water by the account telegraphed to the *Daily News* of the recent accident caused by the "deadly wires," when a horse was killed and a police sergeant shocked. A perusal of the *Daily News* report compels one to indulge in a few reflections; it is astonishing that the correspondent of a great London paper should telegraph such abominable rubbish, and it is also astonishing (though perhaps more excusable as, pecuniarily speaking, the mischief was done when the telegram was received) that the paper in question, which has a reputation for seriousness, should publish it. Perhaps the least curious part of the affair was that the report should create such a sensation that other papers found it necessary or advisable to interview eminent scientific men in order to obtain contradictions of some of the wilder statements published. The beautiful part of the whole business is that the *Daily News* correspondent copied his telegram almost word for word from the glowing account of the accident published in a New York evening paper, which is not generally noted for sensationalism; but on the occasion in question its young man fairly outdid the efforts of the most florid writers on rival publications. The proprietors of the *Daily News* should caution their correspondent to be a little more careful as to the sources from which he selects his "news," especially as regards accidents from electric wires, because we already know, on the authority of the editor of a New York daily, that the subject is written up in accordance with "the public feeling in the matter." In leaving this subject, another reflection occurs. It is certainly curious that all the efforts of the New York journalists to work up the accident

into a sensation quite failed to arouse any interest in the matter here, but the same story (certainly the most highly-coloured version of it) telegraphed to London seems to have created quite a considerable amount of excitement—merely another instance of the truth of the old proverb about a prophet and his own country.

To-day the grand jury have concluded their investigations respecting the vexed overhead wire question, and have handed down to the judge what is characterised as a "strong presentment." It is certainly a very long one, but its strength will only be apparent by the results that may be the outcome of the grand jury's action in the matter; if any real straightening out of the confusion in which the Board of Electrical Control has contrived to land matters should be facilitated by the presentment, its strength and beauty will no doubt be freely acknowledged on all hands. A good deal of the report is devoted to the subway question; as regards the construction of the subways themselves, the necessity for proper regulations restricting the indiscriminate tearing up of the streets by one corporation after the other, it is suggested that, whenever possible, subways should be constructed which would include ample space for gas, steam, and water pipes, traction cables, etc., as well as for the wires, instead of, as at present, allowing each separate interest the exclusive use of a separate part of the street. It is also recommended that the whole matter of subways should be under the control of the Department of Public Works, and that the city authorities should ultimately avail themselves of the city's right, under the Act of 1887, to become the owner of its own electrical subways.

With regard to the deadly wire question, the grand jury regret that they are unable to determine the responsibility for the death of lineman Feeks, since an examination of the evidence before the coroner's jury failed to fix this responsibility beyond a reasonable doubt. From investigating the cause of death of lineman Erdmann (which happened a short time before that of Feeks), they are of opinion that there is evidence obtainable that would enable the responsibility to be placed, and the foreman has handed a memorandum of the same to the district attorney for such action as he shall deem proper. In connection with these and other accidents, the jury call attention to the dangerous practice of stringing electric light and power wires on the same poles with telegraph and telephone wires. It is impossible to condemn this practice too strongly; it is a constant menace to the safety of the linemen, and by the breaking of a wire dangerous currents may be conducted to any house or office by a line which has no business to do anything of the sort.

The concluding paragraph of the "presentment" will not form pleasant reading for the distinguished politicians who compose the Board of Electrical Control. It runs as follows: "The grand jury present to the court that, in their opinion, it was a grave error to entrust such important interests to a commission or board having no practical acquaintance with the subject of electricity, either theoretical or applied. They believe from evidence presented to them that the present Board of Electrical Control have been negligent as well as incompetent, and are largely responsible for the slow and unsatisfactory manner in which the wires are being removed from our streets, and are worthy of censure in this respect, and that, as soon as possible, without the serious impairment of vested interests, this Board should be removed, and the control of electrical subways and service should be entrusted to competent supervision." Hearty concurrence with these sentiments will no doubt be expressed in electrical circles throughout the country. If the recommendations of the grand jury be followed up by the speedy removal of the Board, the jurors will have earned the deep gratitude of electrical men generally. The Board has only acted up to its name in the remarkable wooden-headedness which has characterised all its actions.

Great interest has been manifested here in the highly successful dinner of the Institution of Electrical Engineers. All the technical papers have commented in the most flattering manner upon the success of the innovation, and have reproduced Lord Salisbury's speeches either wholly or partly. It is to be hoped that the success of the Institu-

tion's new venture will induce the American Institute of Electrical Engineers to organise a similar annual gathering. A big dinner, followed by speeches from eminent electricians and representative citizens such as ex-President Grover Cleveland, "Our Chauncey," and a few others, would go a long way towards restoring some of the prestige of which the electrical industry has been robbed by the antics of the "deadly wires" and the bungling incapacity and barefaced jobbery of the Board of Electrical Control.

A report has been going the rounds of the press, both technical and general, to the effect that Mr. Edison has invented a new battery "which bids fair to revolutionise, etc." The new cell is a simple cylinder of zinc in which is placed a stick of caustic soda; you pour in a little water, and there you are. The E.M.F. of this cell is said to be about one volt, and the internal resistance is variously stated as being .25 or .025 of an ohm. The local action is almost nil, there is absolutely no polarisation, and the zinc never requires cleaning. Mr. Edison is reported to have been at work on the idea for over two years and to have made thousands of experiments with almost every known substance to discover a combination which would result in less internal resistance. To judge from the reports, he certainly seems to have found it. To quote a daily paper, "the most sweeping and wonderful claims are made for this new cell"; but perhaps it will be as well to await further developments before speculating too much about it.

The French West Indian Cable Company has been granted authority by the Secretary of State to land cables at Charleston, South Carolina, connecting this country directly by telegraph with Hayti, Santo Domingo, and Cuba. At Hayti the new cable will connect with the existing system of the French company, which extends to La Guayra, Venezuela, thus opening up direct telegraphic communication between the United States and Central America.

ELECTRICAL ENGINEERING IN AMERICA.*

BY G. L. ADDENBROOKE, ASSOCIATE.

(Concluded from page 457.)

An armature made in this way has perhaps an amateurish look about it, but there is no doubt they work well in practice and give excellent results. It is further worth noting that as the field-magnets are long and narrow—a ratio of at least 10 to 1 in the large machines—they cannot be very economical as far as exciting current is concerned. Still, since the exciting current, anyhow, bears such a small ratio to the energy which the machine will transform into electric current, this is not a very material point.

The mains are run from the dynamos to the switchboard in troughs cut in the joists supporting the floor, which is made to take up over these troughs.

The switchboard at Pittsburg consisted of a wooden frame boarded over, about 9ft. high and 12ft. or 14ft. long, and standing about 3ft. from the wall, so as to give room to go behind and make the connections. This, I may say, is the usual way of arranging switchboards in America.

The general type of switch used in America for alternating-current work, and it is not confined to the Westinghouse Company, is exceedingly simple in construction and operation, as well as efficient. In general principle it is like an ordinary tobacco chopper. To the top of a small upright a lever is hinged, terminating in an insulated handle. The metal part of this lever has a hatchet-shaped projection cast on it, projecting in the same plane as the motion of the lever. When the lever is pulled down the hatchet-shaped piece sticks in between two spring pieces set up to receive it, and so makes contact. If the lever has two hatchet-shaped pieces attached to it opposite each other, and engaging in spring pieces on either side, according as the handle is thrown over in one direction or the other, we have a two-way switch. Unite two of these levers together by a cross-bar of insulating material, with a handle in the middle, and we have a double-pole two-way switch. Place a spring in the columns holding the hinges on which the levers turn, to throw down the levers when nearing the spring contact pieces on either side, and we have the complete article.

* Paper read before the Institution of Electrical Engineers.

These switches were all mounted on wooden bases. In fact, I saw no slate used in America anywhere for such purposes, except at the Electric Club in New York. In the new Westinghouse station in Sardinia-street, however, the whole of the switches are mounted on enamelled slate, and very nice they look.

One exciter is used for several machines; each exciter has a resistance in its field-magnets, which can be varied. There is, moreover, a separate resistance in the field-magnet circuit of each alternating machine, so that the E.M.F. of the machine can be varied while its speed remains constant.

Double throw-over switches are connected so that each alternating-current machine can be connected to either of two exciters, and so that any main circuit can be run from any machine. The general principle followed is to keep the machines at work as fully loaded as possible. Thus in the day many circuits will be run off one machine, but as evening comes on they will one by one be taken off and put on other machines. The throwing over is so quickly done as to only just cause a perceptible flicker in the lights. All these switches were bare and unprotected.

I did not hear or see much of the method of running two separate machines parallel on the same circuit. Whatever may be done in isolated instances, it does not appear to be practised generally; indeed, with the American system of running a number of small circuits instead of fewer heavy ones, the desirability of doing so does not often come in.

I should like to endorse here what I see Prof. Geo. Forbes said in his paper on foreign central stations with regard to feeders. The area which can be economically supplied from a central station has certainly been greatly increased by the adoption of 1,000 or 2,000 volts instead of 100. But at the same time our notions of the area which can be supplied from one centre have experienced a corresponding growth.

If, then, such an increased area is supplied on a high-tension system from one centre, we have as great, or nearly as great, falls of potential to deal with as if the low-tension system were used over a correspondingly smaller area.

To secure the highest class of lighting, therefore, together with the flexibility desirable in an installation lighting a large area, the whole of the outside work should be based on as complete and carefully designed a set of feeders as from our present knowledge we should employ with a low-tension system.

On many of the Westinghouse feeders lighting at great distances, there is a fall of potential of as much as 10 per cent. To avoid pilot wires an indicator is used, which, I think, Prof. Forbes has already described here. There is no regular voltmeter for driving the machines by, but an indicator is used with but one single mark on the dial. When the machine is giving the voltage which is required at the further end of the feeder to keep the lamps at their proper brightness, the hand of the indicator will be right over the mark on the dial. The loss in the feeder will, of course, differ according to the current flowing through it, so to allow for this a compensator is attached to the indicator. The main current flows through the compensator, which is arranged to cause a slight back-pull on the needle of the indicator; this pull becomes greater as the current increases. As the current increases, therefore, a slightly higher voltage on the machine will be necessary to keep the needle in its place. The instruments have, of course, to be made so that they can be adjusted to the calculated requirements of each feeder. When once set right, however, their operation is simple enough.

The Westinghouse Company also use a piece of apparatus containing an adjustable converter, which enables them to supply current from the same machine to two feeders having a different fall of potential.

The Thomson-Houston station in New York is situated in Twenty-fourth-street East, near the river, and occupies what was formerly a large sugar refinery. It is, therefore, a building of the warehouse class, but very strongly built. I was told that this station was neither so large nor so well arranged as their station in Brooklyn, but the latter, I regret, I had not time to see. Two boilers struck me here as out of the ordinary patterns. The simplest way to

describe them is I think, to consider them as large locomotive fire-tube boilers set on end. The tubes are about 15ft. long, and the water line is about 10ft. up the tubes. This gives a considerable steam space above, through which the fire-tubes pass, superheating the steam generated, and thoroughly drying it. At first sight one might suppose this an uneconomical pattern, as the heated gases pass so quickly into the flue. But the gases appear to give out their heat well, for Mr. Foster, the station superintendent, told me the temperature of the gases going into the flue was not above 550deg. F. The lower portion of this boiler is, however, the interesting part. I cannot very well describe it without the aid of a diagram. The outer shell of the boiler is expanded out and prolonged about a couple of feet below the tubes. It is turned up at the bottom, and united all round to the crown plate of the boiler, into which the lower ends of the tubes are expanded. This prolongation of the shell then forms a circular hollow, or chamber, about 2ft. deep. The internal space enclosed by this hollow chamber forms the firebox or furnace, and is about 6ft. in diameter. Any sediment collects in the hollow chamber, and can be taken out at manholes. There were two of these boilers in use, and it was in contemplation to increase their number.

The engine—and there is only one—which furnishes power to this station is a large compound condensing Corliss engine; the two cylinders being in tandem. It is a very fine piece of work of its class. It drives on to a large fly-wheel with a smooth face of about 60in. breadth. This fly-wheel transmits its power to a line of countershafting, which is arranged on the floor above, by means of a large leather belt 58in. broad and of great thickness. I think, in all, 17 machines are run from this line of countershafting—15 55-light arc machines and two alternating-current machines; in this case the machines are on the same floor as the countershafting. The general construction of the Thomson-Houston alternating-current machines is on the same lines as those of the Westinghouse Company. The main difference is that instead of the ends of the coils on the armatures being turned over the edge of the core, as in the Westinghouse machine, the armature has a sort of prolonged lip all round the outside at each end, and the ends of the coils lie flat on this instead of being turned over. To their smaller machines, also, the Thomson-Houston Company frequently add a commutator, and commute part of the current to excite the field-magnets, as Messrs. Zipernowski, Deri, and Blathy are in the habit of doing. The switchboard here is on much the same lines as I have already described. It was all quite open and exposed; but I was told that in view of an accident which had happened there a short time before, they proposed to cover the exposed parts up.

This way of leaving the working parts of high-tension alternating-current switchboards exposed is not confined to American manufacturers: a good deal of the continental work is even worse. Yet all the different patterns of switches and converters could be protected at a moderate cost, and by the exercise of a very moderate amount of skill and ingenuity. I cannot help thinking that not to do so, to save money in this direction, is false economy.

ISOLATED PLANTS.

Let us now turn for a few moments from central stations to what are called "private installations" in this country and "isolated plants" in America. I have already spoken of internal construction work, or wiring and fittings, in connection with central stations. With isolated plants there is not much difference. Of course the character of the work differs greatly in different places, as it does here; but, taking it as a whole, I don't think it is equal to our standard, whether from an engineering or artistic point of view. I noticed, by the way, that there is a much greater tendency to turn incandescent lamps upwards in fittings, like gas-jets, instead of downwards, as with us the majority of lamps are turned. Isolated plants are driven by steam and gas engines, located in cellars and basements, exactly like they are here. As you are aware, accumulators are not so generally used; I only saw the set at the New York Electric Club. With respect to dynamos, the Americans

have been fully alive to the developments, both theoretical and practical, in our knowledge of the magnetic circuit which have taken place during the last four or five years, and all their modern machines appeared to me fairly up to date in this particular. What I may be permitted to call the Edison-Hopkinson type, the Kapp type, the Manchester type, and the Weston type—the latter with two magnets, placed horizontally—appear to be the favourites, just as they are here. The construction and workmanship of the machines appeared to be much on a par with our own. There is little to choose between in one or the other. As to the way the installations are run, judging by that crucial practical test, the look of the commutator and brushes, it is much the same as here, certainly, I think, on the whole, not better. The lamps, as a rule, I did not find any steadier, nor are they kept nearer their proper voltage than they are here. This applies to arc lamps as well as incandescent: there is no magic about arc lamps over on the other side of the water; they are subject to the same vicissitudes and uncertainties as they are here, and do not burn steadier than those in any moderate-sized station here where the appliances are such that the lamps get a fair chance.

The switchboards in these private installations are nearly always mounted on wood, and there is even a disposition to cut things fine in the strength and solidity of these wooden baseboards, somewhat, as it seemed to me in one or two instances, at the expense of efficiency and lasting qualities.

ELECTRICAL TRAMWAYS.

Such very full accounts have been published of everything that has been done in this direction, that there is really little I can add to them. In the *Electrical World* for October 19 there is published a table of the electrical tramways in actual operation and under contract in the United States. The total mileage of both is 1,260 miles, with 1,884 cars, on 179 roads. Of this, 716 miles were, it appears, actually being operated by electricity at the date of the return, and 544 miles were under contract. Of this total, 21 miles were worked by cars with storage batteries, and all the rest, with the exception of two or three miles, by overhead conductors.

Nothing can be simpler than the way these overhead conductors are put up. Two lines of posts, about 20ft. high, are set up opposite each other, one on each side of the street; light steel wires are run across from one to the other; a small iron holding-piece is attached to the centre of the steel suspender, and this holding-piece carries a bare hard-drawn copper wire, along which the current flows, returning by the rails. Where feeders are used, they run along one side of the street, and connections are made at intervals with the central wire. The way the conductor is carried round corners is on a par with the rest of the work. Posts are set at the further corners of the street, and from each of these two, three, or four steel wires are run at an angle with each other, meeting corresponding wires run from posts on the inner side of the curve. In this way the wire is made to take the form of part of a rough polygon, while the horizontal and vertical movements of the fishing-rod connector on the car are sufficiently ample to keep the contact-wheel on the wire when the car is going round a corner.

This method of erection does not look very nice, certainly, but it appears to answer the purpose well. Such work could, I think, be more solidly carried out here for about £70 a mile. In a few places standards with projecting arms placed in the centre of the street have been used for carrying the overhead conductor. If neatly constructed, there is no reason why these should be unsightly, and they can be used for the further purpose of lighting the streets.

A great point about these electrical tramcars is the way in which their speed can be varied. They can be run at three or four miles an hour in crowded streets and while turning corners, or in broad roads in suburbs where there is not much carriage traffic, the pace can be increased to 16 miles an hour. The cars are stopped very quickly and reversed, and will, of course, run either way on the same track.

The companies claim a reduction of 50 per cent. in the

cost of working over the employment of horses, putting aside all the extra facilities which the electrically-propelled car gives. A very noticeable point about all electrically-propelled cars is the quiet and gradual manner in which they start and come to rest, and the evenness of their motion while running. In these points they greatly surpass both cables and horses. I took the opportunity of talking with a good many members of the general public in the train and hotels about the working of these cars. There is no doubt that the outside public thoroughly appreciate them and understand their value. At present electrical tramway work is the most "live" branch of the electrical industry in the States, and everyone connected with it was full of buoyancy and hope at its future prospects. It is really sad to think that after all the skill and care which has been lavished on electrical tramway work here, it should be dragging along in such a half-hearted and pottering fashion.

While in America, through the kindness of Mr. Lockwood, I had an opportunity of going over the telephone exchange system of New York with him, and of seeing the Courtland-street exchange, which contains more than 3,500 subscribers, and is capable of extension to double that number. I also visited the Western Electric Company's factories, both in Chicago and New York, where all the telephonic apparatus for use in the States is made. Although a description of the present state of this industry would properly come under the heading of my paper, seeing that the paper has already extended to such length, and that, owing to circumstances, telephony is a matter of comparatively limited interest here, however important in itself, I will not say more about it, but will conclude with a few general remarks.

In the early portion of this paper, I endeavoured to convey an idea of the roughness and crudeness of American outside construction work. After reading over the proofs of the paper, I do not think I have overdrawn the picture; rather it is underdrawn, if anything. At the same time, I do not wish it in any way to be understood that American engineers are necessarily rough and untidy in their ideas, and incapable of different work. Besides their electrical plant, the numbers of beautiful tools, crowned by the latest pattern of the phonograph, which came over here from America, point to an entirely different conclusion. In accuracy of workmanship and careful finish, when they consider it suits their purpose, the Americans are our equals, if not our superiors; the difference lies in the fact that our ideas often differ from theirs as to where this accuracy and careful finish should come in. English engineering would hardly dare to appear before its fellow-citizens as the responsible owner and designer of such a terrible eyesore as American outside work is; but the American engineer appears to look at it from a different point of view. It is not his business to think of his fellow-citizens. Each of his fellow-citizens, he considers, is quite competent and capable of taking care of himself. It is the business of the electrical engineer to forward and extend the applications of electricity. If in doing this he does anything disagreeable to his fellow-citizens, it is for them to protest when it becomes intolerable to them, not for him to think of it beforehand.

And I would like you to try and think for yourselves, and really feel the enormous facilities which American engineers have in the past enjoyed, and still enjoy, in extending their business, by simply being allowed to erect open wires everywhere through the streets. Even where wires are now being put underground, they are largely put underground in order to carry on existing work and to extend it, not merely to take advantage later of what may chance to turn up on the route.

Besides this, we have all had it drilled into us by this time that it does not matter how perfect, how desirable, how useful a thing is likely to be, before it can come into general use the public have got to be educated up to it, to see it, and feels its desirability and utility, and its practicability—to understand it each man for himself. Now, the American system of overhead wires and cheap line construction, bad as it may be in itself, has from the very first brought electricity home to everybody, right to their very doors, not so much as a luxury, but as a practical desirable

factor of everyday life, an attraction to public resorts, and a good advertisement for business. Consequently, electricity is in America no more a wonder, but a fact of everyday life to an extent that it is not yet here.

Looking at their plant, looking at their apparatus, and looking at the facilities which Americans have enjoyed for extended practical experiments on a large scale, it does not appear to me that their actual achievements, simply from an engineering and scientific point of view, have been greater than ours have, in spite of the apathy on the part of the public and investors with which we have had to contend. Still, the fact remains that they have done more business than we have, even considering the difference in population.

Of what work we have done so far, Englishmen may feel justly proud, and with better times I trust we may still be able in friendly rivalry to show that we are competitors worthy of America's best mettle.

AUTHORISED ABSTRACT OF DISCUSSION.

The **President**, in inviting discussion, remarked that a paper of such interest could not be adequately dealt with in the time then at their disposal, and announced that the discussion would be continued at the next meeting on Dec. 12. In the meantime, printed copies of the paper can be had on application to the secretary.

Prof. Forbes admired the realistic description of electrical work in the United States given in the paper, and fully endorsed the author's account of American electrical engineering, particularly as regards the rough-and-ready way in which the work is usually carried out. Although this class of work may be necessary for the rapid extension of electric lighting (as well as of railways) in America, where great distances have to be covered, yet he thought the more solid construction adopted by English engineers would prove better in the long run. For some time past he had frequently heard of great advances made on the other side of the Atlantic, and expected to have heard something definite about them from Mr. Addenbrooke, but, with the exception of electric tramways, little change seems to have been made since his visit two years ago. At that time, however, most tramways were worked by accumulators. Information about motors and meters would have been very acceptable, particularly for alternating-current work. Speaking of American factories, Prof. Forbes said that great attention was paid to testing, and as a result the efficiency of converters had been considerably increased. As regards distribution, he was glad to hear of the frequent use of feeders, and hoped they would be more generally adopted in England. In conclusion, he asked what kind of cable is used for underground work.

Mr. H. C. Donovan considered that the apparent disregard of insulation was to be attributed to the dryness of the climate, and expected to have seen this brought out in the paper.

Mr. W. P. Granville said the usual method of specifying insulation resistance of cables (viz., in megohms per mile) was unsatisfactory, and that the diameter of the conductor should be taken into account, for if this is not done the same material used on conductors of different sizes would give quite different insulation resistances. He also thought that the insulation tests of lead-covered cable should be made before sheathing, and whilst the cable is immersed in water. In his opinion the whole subject requires reconsideration.

Prof. S. P. Thompson had hoped to hear that in the five years since he visited the States improved methods of wiring, etc., would have been adopted, but no great change seems to have taken place, excepting in the use of alternating currents. On his visit, he obtained an insulator even more crude than the one described by Mr. Addenbrooke. This he promised to exhibit at the next meeting. After making enquiries as to the kind of motor used in the constant-current arc circuits, Dr. Thompson expressed his opinion that the alleged greater steadiness of American arc lights was not due to any superiority in the design or workmanship of the lamps, but to the greater personal pride and confidence which the attendants have in the particular system with which they are connected.

Mr. Swinburne pointed out the great difference which exists in the management of English and American factories, and thought the system adopted in the latter, where the perfecting of designs and the experimental work are kept quite distinct from the wholesale manufacturing part of the business, was most likely to lead to success. So far, however, he believed machines of English design better than American, for the weight efficiency of the former is generally higher. Referring to Mr. Granville's contention, he said that instead of insulation resistances being given in megohms per mile, they should be expressed in megohm miles for each size of conductor.

The **President**, whilst deprecating imperfect work in general, thought it advisable that English electricians should acquire whatever good could be got from the "rough and ready" method adopted in America, and considered that progress might be retarded by waiting too long to attain perfection. He was anxious to know how constant currents were used for motors, and also whether the overhead wires used for tramways interfered with the ordinary street traffic.

Replying to Prof. Forbes's question as to recent advances, **Mr. Addenbrooke** said he had not concerned himself with them, for his object was to see the systems and apparatus in common use. As to motors, he made no enquiries respecting their peculiarities, but as regards meters, he was informed that numbers of the Westinghouse type were in constant use. He agreed with Prof. Forbes about the way in which testing is appreciated, and with Prof. Thompson as regards the interest which the men take in their work—the latter fact

Mr. Addenbrooke attributed to better wages and greater chances of promotion. Speaking of the insulation of cables, he thought the absolute thickness of insulating material should be stated. In reply to the president's question relating to tramway wires, Mr. Addenbrooke pointed out that they were placed eight or nine feet above the tops of the cars, contact being made by a "fishing-rod" connection. In some cases these wires are carried by brackets projecting from poles fixed along the middle of the roadway, the poles being also utilised for supporting arc lamps and for general lighting circuits.

ELECTRICAL TRANSMISSION OF POWER IN NEW ZEALAND.

We have received from Mr. R. H. Postlethwaite, A.I.E.E., Geraldine, New Zealand, a written description, and also a copy of *The Press* containing a full report of an inspection of the works at Temuka. For this our local contemporary has published a report of this inspection, given below, which would put to shame many reports of electrical matters that appear in papers at home. The success of this transmission plant should lead to business, and our makers should keep a good look out for colonial agents who are as enterprising as Mr. Postlethwaite. This gentleman writes, among other things: "The machines are both series wound, and with the aid of the Fruen governor keep a constant speed on motor spindle. The dynamo runs absolutely sparklessly under all variations of load without alteration of brushes. The distance between machines is 63 chains, with a line resistance of two ohms. Resistance of each machine, 2.65 ohms. Commercial efficiency at full load, 71.5 per cent. Line insulation, 1.4 megohms. Total insulation with everything in circuit, machines, instruments, etc., 107,000 ohms." The *Press* report is as follows:

"The works are those formerly owned by the Temuka Linseed Company, but now being carried on under the proprietorship of Mr. W. Postlethwaite, Mr. R. H. Postlethwaite, A.I.E.E., Mr. R. Barker, and Mr. Brown, and consist of plant and premises admirably suited for carrying on a large business in flax dressing and the manufacture of binding and other twines. On arriving at the works the visitors were invited to a luncheon laid out in the twine spinning room. This refreshing ordeal over, a move was made in the direction of Messrs. Aspinall, and Co.'s flour mills, about a mile distant, on the banks of the Waihi, at which point has been erected the dynamo-house. Just previous to entering this building there was a wholesale delivering up of watches to one of the company, the idea, of course, being to prevent them suffering injury from magnetism. The dynamo is one of Statter's, and is a machine that Mr. Postlethwaite had specially designed while in London last year. The power required for driving the dynamo is obtained by means of a turbine wheel erected at one end of the mill dam. The turbine is capable of giving 40 h.p., with a 12ft. fall, but at present only about 20 h.p. is required at the dynamo. The turbine has a 30in. new American wheel, running at 130 revolutions per minute, the drivers being helical teeth gears, which drive the countershafts at 260 revolutions. One of Fruen's patent governors is attached, which is made to operate so directly on the turbine gates that it ensures a perfectly steady power at the motor end, notwithstanding that the power here is constantly varying as the hanks of flax are being fed into the scutching machines from less than 1 h.p. up to 13 h.p. The dynamo is driven from the turbine wheel by a 6in. patent leather link belt, the dynamo or generator going at the rate of a thousand revolutions per minute. In addition to the turbine governor there is an electric governor to alter the lead of the brushes, and while it assists in keeping the speed of the motor constant. On the switchboard there is an ampere-meter and a voltmeter for registering the quantity and strength of the electric current. There is also an ingenious and exceedingly useful safety device, which, in the event of anything happening at any time to unduly enlarge the current, will immediately short-circuit the field-magnets, and so prevent any possible damage to the insulation, or danger of damage to any other part of the machinery. This device Mr. Postlethwaite claims to be a very great improvement on the ordinary 'cut-out,' or

actual cutting of the main current, as, in the case of the latter, if done on a high-tension circuit, a serious spark (owing to the self-induction in the machine) would result, and cause great injury to the insulator. The generator on full load will give 24 amperes and 570 volts, representing 15 h.p. at the motor end, thus the actual efficiency of the whole insulation is 71.5 per cent. of the power registered at the dynamo. The distance the power has to be transmitted is a trifle short of a mile. The wire transmitting the current from the dynamo to the motor is of 7/14 hard-drawn copper. This is larger than is necessary for present requirements, being capable of transmitting some 40 h.p., but it has been erected with the view of the power being duplicated at some future time. The dynamo-house and the works are connected by telephone. The electric motor, which is also one of Statter's, is erected in a building adjoining the scutching-room. It requires little or no attention, and there is absolutely no noise, offensive smell, or danger from fire. On one side of the motor-room Mr. Postlethwaite has fixed up nine 16-c.p. electric lights, and so nicely regulated is the power that these give an absolutely steady light. The closest and most prolonged observation failed to detect the faintest variation in the light. This is a point of great importance, as showing that with the independent governing attachments at the dynamo or supply station, etc., the power can be utilised with perfect success for simultaneously driving any class of machinery and producing a beautifully soft and absolutely steady light.

"The electric transmission plant, as now in use at the Temuka Hemp Mills, has been working a fortnight, and from the moment it was switched on up to the present it has worked with the most perfect success, even to the most minute detail. All the work has been done under Mr. Postlethwaite's immediate supervision, and a very great deal of it by his own hand. He contracted with the mill proprietors to put the machinery in, and in doing so gave a guarantee that he would do so, and take it out again at his own cost in three months if not a success. It has proved a complete success, and Mr. Postlethwaite is deserving of great credit alike for his enterprise and skill, and for introducing into the country so important a departure in motive power. The transmission plant as it now stands has cost £800, but provision has been made for duplicating the whole of it, and this can now be done for an additional £300. It is estimated that the new power will effect a saving of at least £100 a year as compared with that used formerly, and if the mills are kept going night and day in place of eight hours a day, a saving of £600 a year can be effected. It will be interesting to note that the development of the application of electric motors to machinery has been making great strides in America, and there is now a total of about 6,000 in use, 4,000 of which were put in operation during 1888. Indeed, so great is the demand for electric motors for the working of all kinds of machinery in America, that many of the large works are kept going 24 hours a day, in order to keep pace with the orders for a power that seems destined to supersede steam or gas. Mr. Postlethwaite has been appointed sole agent for New Zealand for the Electrical Engineering Company, and he feels confident that he will have the pleasure of introducing many electric motors in various parts of the colony. He has seen them used with great success in many parts of the United States, and feels sanguine as to their future, and that it will pay to use them."

It may also be interesting for us to mention that during the past few months Mr. Postlethwaite has installed the electric light in three flour mills, one skating rink, in shops, and in one country house. And he hopes to have a central station going shortly in Christchurch to supply both light and power. Bravo, New Zealand, and congratulations to your enterprising Mr. Postlethwaite!

Royal Meteorological Society.—The secretary of this society gives notice that the draft list of officers for 1890 will be prepared at next council meeting, Dec. 18th. Those of the Fellows who wish to send names should do so before that date.

A STORAGE BATTERY ROAD IN PHILADELPHIA.

Our contemporary, the *Street Railway Journal*, of New York, calls especial attention to a new storage battery line of street railway to be opened for business in Philadelphia. It is contended that if storage battery construction is as yet commercially feasible, it will be demonstrated on this road, and we have much pleasure in giving a description of this line from our contemporary.

A new line of electric railway to be operated entirely by means of storage batteries has been quietly building in Philadelphia for some time past, and has just been completed. The fact that, with perhaps one very recent exception, it is so far the only street railway in this country which depends solely on accumulators for its motive power; not a grain of oats, not a halter or stall, in short, no provision whatever having been made for horses, and that its arrangements differ in many respects from those usually to be found on street railways, cannot fail to make it interesting to all who are engaged in street railway business.

The power plant is placed at one end of the line, and the tracks terminate within the building. The station entrance is in Thirty-second-street, where the cars leave and enter, the passengers who come and go passing through the opposite end, which fronts on Ridge-avenue. This building is of a heavy brickwork, and is very substantial. Ample space has been allowed for manipulating the cars and the batteries, and the best accommodations have been provided for the comfort and convenience of passengers. The depot proper is about 154ft. long by 74ft. wide, within which are situated the women's waiting and retiring rooms, men's waiting-room and office, all steam-heated, and fitted with incandescent electric lights, and covering collectively a floor space about 30ft. by 50ft., and the engine-room, 30ft. by 39ft. Placed between the waiting and engine rooms are the battery charging and transfer tables, which form a distinctive feature of the station. The remainder of the floor space within the depot is given up to the three tracks, crossovers, and switches, and the car-pit, 10ft. wide by 40ft. long and 3ft. 9in. deep, of sufficient length to take two cars at once. This pit is specially constructed with space enough between the stringers supporting the rails and its sides to permit of convenient inspection of journal-boxes, motors, brakes, and other gear. The depot has a capacity of 18 cars, and switches and crossovers are all conveniently arranged. The doorway through which the tracks pass leading to the double track without, has a span of 39ft. 7in., and is 12ft. 3in. high. The engine-room contains a 100 h.p. Armington and Sims engine, which drives two dynamos of sufficient capacity to charge 10 sets of the storage cells used in the cars, and also furnishes power for the 10-light Ball arc dynamos used for the interior and exterior illumination of the station, and for lighting up the switchboard. A well-lighted boiler-room, 36 x 40ft. immediately adjoins the engine-room. So far only one boiler of 100 h.p. capacity is installed, but there is ample provision for doubling the entire power plant when necessary. In order to render the station independent of the city water supply, should it happen to give out at any time, a well 6ft. in diameter by 50ft. deep is provided, with an available capacity of 4,600 gallons, and, by means of a steam-pump, keeps a 10,000 gallons reservoir tank constantly filled, and also supplies the boiler feed-pump with water through a floor cistern in boiler-room. The dimensions of the chimney are 43in. by 43in. and 70ft. in height. The road to be operated extends from this station to Second-street and Lehigh-avenue, and is in all somewhat over three miles of double track. The maximum grade is 5 per cent., 400ft. long. Other grades are 3.7, 3.4, and 3 per cent., each 500ft. long, the remaining grades varying from 1 per cent. to 2 per cent. There are no appreciable level stretches. The route is across the northern part of the city, and offers exceptional advantages to the residents of rapid and convenient transit from Richmond and Kensington in this northern quarter to the pleasure-grounds about the Strawberry Mansion in Fairmount Park, and to the cemeteries in the vicinity of the Ridge-avenue terminus. The initial equipment will consist of six closed cars, five being 16ft. cars, each equipped with two 10 h.p. motors, and one,

a 22ft. car with double trucks, propelled by two 15 h.p. motors.

The system of handling the batteries is very simple and convenient. Tables are provided, mounted on wheels, which travel on cross tracks, and these tables have space enough for four cases or frames of batteries, which represent the number of exhausted and freshly-charged batteries for one car. The top of the table is fitted with rollers and also pinions, the end one of which can be turned by a crank handle, and which engage with a rack on the bottom of each battery case. The floor of the car under the seats is also fitted with rollers and pinions. When a car comes in from a trip, the table containing the two newly-charged cases of batteries is advanced to a convenient position, and the batteries being run out of the car through the end panels and through corresponding openings in the dashboard on to the table, it is shifted slightly, and the new set of cells is run in and automatically connected; one man and a moment or two being all that is needed to accomplish this "change of horses." The motors differ radically from any so far brought out, having been specially designed for the purpose. The power reaches the axles through worm gearing, which runs in oil within a suitable casing, and is noiseless and very durable.

Throughout this entire plant nothing but the best of everything has been used; the electrical equipment of the cars has been put to all manner of tests covering a long period, and every imaginable exigency which is ever likely to arise in service has been anticipated and provided for, and we expect to see the Lehigh-avenue Railway an unqualified success.

PROF. JAMIESON ON ELECTRIC LIGHTING FIRE RISKS.

Prof. Jamieson, M.I.C.E., lectured to the Insurance and Actuarial Society of Glasgow, in the Accountants' Hall on Monday, on "Fire Risks, etc., due to Defective Installations of Electric Lighting and Defective Lightning Conductors." Mr. Thomas Marr, of Scottish Amicable Office, occupied the chair.

In the first place, Prof. Jamieson showed the great and rapid progress lately made in electric lighting and the transmission of power by electricity, reminding the audience of the first exhibition of incandescent lighting by Mr. Swan, the inventor of the Swan lamp, at the Philosophical Society's rooms in 1881, when Sir William Thomson prophesied that within a very few years we should all adopt the electric light as our means of illumination, reserving gas for its legitimate purpose of cooking our food and heating our rooms. He then drew attention to the Chamberlain (1882) Electric Lighting Act, which, owing to the compulsory purchase clauses, etc., retarded electric lighting progress in this country. But now, he went on to say, all these objectionable measures had been superseded by the 1888 Act, by which public confidence was rapidly becoming ensured, and capitalists were investing their money in electric lighting companies. Every town worth mentioning was at the present moment being assailed by electric lighting companies applying to the Board of Trade for leave to start central stations; and even the naturally slow-moving corporation was bestirring itself, if for no other reason than that of preventing rivals from entering within their walls. It was, therefore, the lecturer thought, very fit and proper for insurance men to have lectures and discussions on the subject, inasmuch as they were bound to consider the changes which were always taking place in every form of illumination—changes which had to be specially guarded against in electrical installations, owing to the novelty and mystery surrounding every application of electricity; and, further, to the fact that electricity was invisible and inodorous, and that it specially laid itself open to fraud and deceit, for every bell-hanger who had run up an electric bell wire thought that he might similarly put up an electric light installation in the same happy-go-lucky manner. It behoved the insurance companies to guard not only their own interests, but also those of the public. Dividing his subjects into 10 heads, Prof. Jamieson (1) gave a general idea of the action of electricity flowing along a conductor, which he compared to water under pressure flowing along a pipe; and showed how, without touching the wire, one could detect the presence, direction, and strength of the current flowing along. (2) He drew attention to the risks arising through the use of imperfect and too small conductors, and by experiment, from a set of storage cells or accumulators, which had received their charge last week from the Glasgow and West of Scotland

Technical College dynamo, he rendered a wire red-hot, and set fire to some waste, thus showing the absolute necessity for properly proportioning the size of conductors to the current carried. (3) He exhibited specimens of the Fowler-Waring cables, which, if report be correct, are to be employed in conveying electricity from Deptford to London at a pressure of 10,000 volts. He then showed some very bad specimens of joints, and came down severely on such slovenly work. (4) Insulation resistance and insulating materials were next dealt with, the lecturer giving his own rule as well as that of the Institute of Electrical Engineers for the necessary insulating resistance under different circumstances. (5) He exhibited and illustrated the necessity of properly proportioning "cut-outs," illustrating his remarks by the experiment of protecting a circuit by the fusing of a wire therein. (6) He referred to switches, drawing attention to the necessary requirements in them and in lampholders. (7) He showed some specimens, in which so severe electro-chemical action had been set up as to break down the circuit, and set fire to part of a ship. (8) He urged most strongly the necessity for thorough inspection and testing. (9) He briefly discussed the fire risk rules of the Institute of Electrical Engineers, the Phoenix rules, and those of the Westminster Fire Office, remarking that although the Phoenix rules were no doubt very complete, and had been of excellent service in the past, yet he could not help thinking that they might be made much more concise, and leave fewer loopholes for the idiosyncrasies of fire office inspectors. (10) He exhibited some specimens of lightning conductors, explaining their construction and action, and the fire risks to which buildings were liable from defective material and erection.

An interesting discussion followed, taken part in by Mr. Smiley, Mr. Bryson, Mr. Mavor, and other electrical engineers and fire insurance officers. Several of the points discussed by Prof. Jamieson, notably insulation, were canvassed, and most contradictory views were expressed, almost the only matter on which the engineers agreed being condemnation of the rules laid down by the fire offices. Firemaster Paterson asked the opinion of the experts present as to how his men could best guard against the dangers to them personally arising from breakage and other casualties to high-tension wires in case of fires, and received a few practical hints from Mr. Mavor and others, who declared that the risk was really very small. A hearty vote of thanks was awarded Prof. Jamieson for his lecture.

COMPANIES' MEETINGS.

FOWLER-WARING CABLES COMPANY, LIMITED.

The statutory general meeting of the shareholders of the Fowler-Waring Cables Company, Limited, was held last week, at Winchester House, Old Broad-street, E.C., under the presidency of Mr. W. Fowler.

The **Secretary** (Mr. G. Neill) read the notice convening the meeting.

The **Chairman**: Gentlemen, it is my duty to state to you just what has happened since the Company was formed. You are aware that this is not a meeting for business, but merely a formal meeting which we have to hold, under the Act of Parliament, within four months of the formation of the Company. You will understand that, immediately the Company was formed, the first point we had to consider was, where shall we proceed to work, and to arrange for procuring machinery and the other things necessary for the work of the Company? We decided, if possible, to have our work commenced in London, and after a great deal of enquiry, we found a place on the Thames at North Woolwich, formerly used by Mr. Henley, a great maker of cables some years ago, but long since deceased. It was a curious fact that in Mr. Henley's time I went down to see his works at Woolwich, and when it was suggested to me that this place was lying idle and would be suitable for our works, I at once acquiesced. We, therefore, after a deal of consideration, made a compact with the owners of this property, by which we were to have this property for a certain time at a very moderate rental, with the option, within four years, to purchase the freehold at a rate which is just about 20 years' purchase of the land and buildings. Last week I renewed my acquaintance with the place, after we had done a good deal of work upon the premises; and I assure you I was astonished to find how accurate my recollection had been, for the character of the buildings was such that I am certain that we have made a most excellent bargain. I say so without hesitation, because the selection of the premises was more that of other people than mine, although I gave it my hearty approval. It will, of course, cost us something to alter the premises to carry on the business, but that will not be a very material matter, because the buildings are so substantial and so grand in their structure, if I may use that term with reference to manufacturing premises, that I really believe it would cost you all the money that we shall have to pay for that place to put such buildings up to-day. I therefore think that we have not lost any time, and that we have done work for you which will be very satisfactory in the result. The machinery is actually, to some extent, on the spot, the engines and boilers are up, and this very day the shafts are turning round, and I believe very early in the next year (1890) we shall be in a position to take orders there for cables.

Of course, as you are aware from the prospectus, we have not been without business in the meantime, because, under the arrangement with the firm of John Fowler and Co., of Leeds, they hand over to us the profit on their business, less a fair percentage for their work, and they have been busily making cables ever since the time the Company was formed, so that we are really earning some money now, and I am confident that this Company will be a real success. I am exceedingly cautious in making promises and prophecies. I think they are both very dangerous things, but I believe that we have got hold of a business which will be very satisfactory to you as shareholders. I really do not know that I have anything else to say; but I repeat that we have not lost an hour in endeavouring to set to work, and we are likely to set to work practically within four months of the formation of the Company. I think we could not do more than that, and it is only by the accident of finding this place all ready for use that we are able to make that statement. If we had to buy land and put up our buildings I do not believe that we should have done it much under a year; but as it is, we are likely to set to work within four months of the formation of the Company. I have no motion to move, but I have simply to make this general statement. I shall be delighted to answer any questions that any gentleman may put to me.

Mr. Potter said: It is through me that a considerable number of shares were taken in Leeds. Something has recently occurred in Leeds which has exercised the minds of some of the large shareholders there. We understood that our mode of making cables by covering them with lead was the only one that there is, and that the patent rights were secured in this country. At the present moment, in Leeds, cables are being laid which appear to be the same thing, and to relieve our minds I should like to ask if it is the same as ours, and how it is that there is such a thing going on when we thought we had the monopoly. The cable I refer to is being laid near the Queen's Hotel, and although the core of the thing looks different it looks like a lead-covered cable, similar to the Fowler-Waring.

The **Chairman**: I should like Mr. Eddison to answer that question.

Mr. Eddison: The cable that you refer to as being laid at Leeds at the present time is one supplied from Chicago by the Western Electric Company. The centre of the core of the cable is formed, and it is then drawn into a lead pipe, but it is not covered in the method we adopt. The American cable is covered in very short lengths. Ours is not. But I may also add that the National Telephone Company have given us an order for Leeds, and our cable will be laid next week, and it is double the length of the American cable.

Mr. Potter said that that was the answer he expected.

The **Chairman**: I am very glad you have asked the question. I think it is quite clear that the American cable is different to ours. If we found anyone infringing our patent we should very soon take action.

Mr. Eddison: If you examine the cable you will find a plumber's joint at very short distances.

The **Chairman**: It is quite obvious that we may not begin an action until we are quite sure.

This concluded the statutory meeting.

An extraordinary general meeting of the Company was then held to make certain alterations in the articles of association.

The **Chairman** explained the alterations had been required by the committee of the Stock Exchange, and were of an unimportant character. The principal alteration suggested was to strike out certain words in article 37, the object of which was that the dividends should only be payable out of the net profits of the business, which he was sure they would all admit was perfectly right. He then formally moved the resolution embodying the alterations.

Mr. Fleming seconded the motion, which was unanimously agreed to.

The **Chairman** observed that the alterations would require to be confirmed at a subsequent meeting.

Mr. Gathorne-Hardy proposed a vote of thanks to the Chairman.

The resolution was seconded by **Mr. Potter**, who said he was much struck with the clear and business-like manner in which the proceedings had been conducted.

The resolution was carried, and the **Chairman** briefly acknowledged the compliment, which concluded the proceedings.

NEW COMPANIES REGISTERED.

Foreign and Colonial Electrical Storage Company, Limited.

Registered by Messrs. Renshaws, solicitors, 2, Suffolk-lane, E.C. The nominal capital of the Company is £100,500, divided into 20,100 shares of £5 each, whereof 100 are founders' shares and 20,000 are ordinary shares. Object: To adopt a provisional agreement, dated November 22, 1889, and made between the Electric Construction Corporation, Limited, of the one part, and George Newington, on behalf of this Company, then about to be incorporated, of the other part, being an agreement with reference to the sale and purchase by this Company of certain patents for improvements in storage batteries and other property therein mentioned, and to carry the same into effect, with such (if any) modifications or alterations as may be agreed upon. The first subscribers are:

	Shares.
Sir D. Cooper, G.C.M.G., 8, De Vere-gardens, W.	1
J. Irving Courtenay, The Temple, E.C.	1
J. Balfour, 4, Marlborough-gate, W.	1
J. Pender, Thornly Hall, Rugby	1
F. Green, 13, Fenchurch-avenue	1
R. Mackenzie, Dingwall Lodge, Croydon	1
T. H. Horwood, 43, Woodstock-road, W.	1

The number of Directors shall be not less than three nor more than seven, and the first shall be Sir Daniel Cooper, G.C.M.G., J. Irving Courtenay, James Pender, J.P., James Balfour, and Frederick Green. The qualification of a Director shall be the holding in his own name 100 shares of £5 each, or £500 stock, and this qualification shall be required as well of the first as of all future Directors. The Directors shall be entitled to receive as their remuneration £1,000 annum when the dividend on the ordinary shares does not exceed 10 per cent. per annum; but if the dividend exceeds that sum, then the Directors shall receive an additional remuneration 10 per cent. of all profits earned in excess of the said dividend of 10 per cent. per annum, provided that the total of such remuneration shall not exceed £5,000 in any one year.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for the week ended December 6 amounted to £4,944.

Cuba Submarine Telegraph Company.—The traffic receipts of this Company for November were £3,000, against £3,107. The receipts for August, estimated at £2,700, realised £2,815.

Great Northern Telegraph Company.—The receipts of this Company for November were £23,200, making a total from January 1st of £252,400, against £250,200 and £242,880, for the corresponding months of 1888 and 1887.

Western and Brazilian Telegraph Company, Limited.—The traffic receipts for the week ended December 6, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,538.

Companies of the Month.—The following electrical companies have been registered during the past month:

Batava, Limited, £1 shares	£100,000
Birmingham Safe Deposit Company, Limited, £5 shares...	20,000
Lange and Co., Limited, electrical engineers, £5 shares.....	10,000
Llanelli Electric Light and Power Company, Limited, £1 shares	15,000
National Electric Supply Company, Limited, £5 shares ...	100,000

Westminster Electric Supply Corporation.—A provisional order, under the Electric Lighting Acts, for supplying electricity in Westminster, including Mayfair, Belgravia, and Piccadilly, having been obtained by this corporation, the issue is announced of 60,000 shares of £5 each, of which 20,000 have already been taken. The founders of the Company waive all claim to compensation beyond their actual expenditure and the 100 founders' shares, for which they have subscribed, and which are entitled to one-fourth of the surplus profits after 7 per cent. has been paid on the ordinary shares. The Company is authorised by their Act of Parliament to charge a maximum of 8d. per unit; but the Directors anticipate being able to supply the light profitably at a lower figure.

PROVISIONAL PATENTS, 1889.

DECEMBER 2.

19304. **Improvements in electric motors and dynamo-electric machines.** William Brooks Sayers, 24, Glycena-road, Lavender Hill, London.

19335. **Improvements in voltaic batteries.** James Compton Merryweather, Greenwich-road, Kent.

19354. **Improvements in and relating to relays for telegraphic purposes.** Hugo Lubliner, 45, Southampton-buildings, London.

DECEMBER 3.

19379. **Improvements in electric switches.** Bernard Mervyn Drake, John Marshall Gorham, and Elijah Atkins, 2, Prince's-mansions, Victoria-street, Westminster.

19389. **Combined electrical steering and rudder indicating apparatus.** William Henry Willatt, 28, Witham, Hull.

19409. **Electrical pipe lighter and advertising device.** Edward Manville and William Leonard Madgen, 3, Prince's-mansions, Victoria-street, London.

19420. **Improvements in alternating current electro-magnetic motors.** Henry Harris Lake, 45, Southampton-buildings, Middlesex. (Nikola Tesla, United States.) (Complete specification.)

19426. **Improvements in the construction and mode of operating alternating current motors.** Henry Harris Lake, 45, Southampton-buildings, Middlesex. (Nikola Tesla, United States.) (Complete specification.)

19433. **Improvements in conduits or casings for subterranean electric lines.** Franz Zöpke, 226, High Holborn, London.

19450. **An electro motor worked by alternating currents.** Maurice Leblanc, 28, Southampton-buildings, London.

DECEMBER 4.

19453. **Improvements in or relating to the construction and arrangement of machinery and apparatus for the installation of an electric accumulator.** Wilfrid Swanwick Boulton, 24, King's-mountain, Birkenhead.

19478. **A hollow metal curb for street pavements to contain electric wires.** John Springeour, 97, Newgate-street, London.

19484. **Improvements in electrical switches specially applicable for electric vehicles fitted with two motors.** Frederik Vilhelm Andersen, 40, Chancery-lane, London. (Complete specification.)

19491. **Improvements in electric batteries.** Gustave Philippart, 6, Bream's-buildings, London.

19495. **An improvement in arc electric lamps.** Thomas Barnet Grant, 28, Southampton-buildings, London.

19497. **An improved electric meter.** Herbert John Dowsing and Joseph Appleton, 115, Cannon-street, London.

DECEMBER 5.

19525. **Improvements in electricity meters.** William Harding Scott and Laurence, Paris, and Scott, Limited, Gothic Works, King-street, Norwich.

19529. **Improvements in current collectors for electric dynamo and other machines.** Edmund Holt, New Bridge-street, Manchester.

19554. **Improvements in the connections of alternating current generators and electric motors.** Michael von Dolivo-Dobrowolsky and the Company Allgemeine Elektrizitäts-Gesellschaft, 47, Lincoln's-inn-fields, London.

19555. **Improvements in electrical induction apparatuses or transformers.** Michael von Dolivo-Dobrowolsky and the Company Allgemeine Elektrizitäts-Gesellschaft, 47, Lincoln's-inn-fields, London.

19573. **Improved insulating material for electrical conductors.** Gustav Louis Hille, 28, Southampton-buildings, London.

DECEMBER 7.

19692. **Improvements in poles or supports for electric conductors and similar purposes.** Guillaume Arnaud Nussbaum, 29, Ludgate-hill. (Nicolas Oscar André, France.)

SPECIFICATIONS PUBLISHED

1888.

16623. **Electricity meters.** Laurence, Paris, and Scott, Limited, and another. 8d.

16946. **Incandescent electric lamps.** Johnson (Mace). 8d.

18319. **Suspenders for electric lamps and shades.** Boulton. 8d.

18653. **Electro chemical generators.** Brougham (La Société Perreux-Lloyd and Fils). 8d.

18968. **Electric primers for mines, &c.** Zalinski and Smith. 8d. 1889.

282. **Conduits for electric mains.** Coates. 6d.

342. **Dynamo-electric machines.** Mordey. 4d.

614. **Electric locking switch.** Naylor and Naylor. 8d.

765. **Type-printing telegraph apparatus.** Abel (Siemens and Halske). 8d.

1460. **Secondary battery plates.** Sellon. 6d.

1537. **Electric lighting.** Boulton (Doubrava). 8d.

8439. **Conduits for cable railways, &c.** Pendleton and others. 1s. 3d.

9977. **Giving motion to percussive tools by electricity.** Thompson (Marvin). 6d.

13800. **Secondary batteries.** Heyl. 6d.

14232. **Dynamo-electric machines.** Allison. 8d.

15377. **Electric machines.** Peck. 8d.

15721. **Electric motors.** Grosvenor. 8d.

15775. **Electro-dynamic machines.** Winkler. 8d.

15821. **Secondary batteries.** Currie. 8d.

16144. **Electric tell-tale apparatus.** Hayman. 6d.

16231. **Dynamo electric generators.** Pfannkuche. 11d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.	Name	Paid.	Price Wednes- day
12 Feb. 1/2	Anglo-American Brush E.L.	—	3½
12 Feb. 2/0	— Pref.	—	2½
14 Nov. 0/4½	Con Telephone & Main ...	1	2½
27 July 10/0	India Rubber, G. P. & Tel.	10	17½
.....	House-to-House	4½	5
.....	Metropn Electric Supply	—	4½
.....	London Electric Supply ...	5	3½
.....	Swan United	3½	5
2 July 12/0	Telegraph Construction ...	12	45
2 July 6/0	— 6%, 1889	100	105
.....	National Telephone	5	6½

NOTES.

Brussels.—The goods station of Allée-Verte at Brussels is to be lighted with electric light.

Moore and Burgess.—The Moore and Burgess Minstrels' hall is closed till Boxing Day for the purpose of having the electric light installed.

Hanover.—The town of Hanover has decided to have a municipal central station of its own, and a committee has been appointed to carry this resolution into effect.

New Business.—Messrs. Poole and White are commencing business on January 1st next, at 58 and 59, Bread-street, City, with the supply of electric lighting necessities.

Rochester.—The Rochester Town Council have instructed Mr. Moulton, Q.C., to give the Corporation his opinion on a proposed provisional order of the Chatham Electric Light Company.

Breslau.—The committee appointed to consider the question of electric lighting for the town of Breslau has recommended the Municipality itself to undertake the construction and working of a central station.

Bremen.—At an industrial exhibition which is to be held at Bremen next year, the local tramway company have decided to install a Thomson-Houston electric railway. The new line will be also lighted throughout its length with some 50 arc lights.

Electrical Marriage.—Mr. W. G. Johnston, the enterprising president and publisher of our esteemed contemporary, the *Electrical World*, was married in New York City, on December 3rd, to Miss Grace W. Johnston. We tender our sincere felicitations to our American confrère on this auspicious event.

Hastings.—As some doubt was thrown on the statements and figures of the Hastings borough surveyor with reference to the utilisation of the dust destructor in electric lighting, this gentleman obtained an independent estimate and embodied his proposals in a report to the committee. The report was discussed and agreed to.

Colonial Telephones.—Long-distance telephoning is the latest of colonial improvements. Newspapers published at 50 or 60 miles from Melbourne now get their late parliamentary reports by telephone, and the news thus supplied is not only more ample, but far more accurate than was possible under the old telegraphic system.

Paris Lighting.—According to the *Bulletin Internationale de l'Electricité*, the number of lamps in Paris at the present time is, incandescent lamps, 63,000, and arcs about 900. A certain number of the municipal councillors have signed a petition to make the electric lighting a municipal function, and to create a general municipal service of electric light for Paris.

Heyl Accumulator.—Herr Heyl, of Charlottenburg, Prussia, makes his accumulator plates with felted lead. He hangs very thin lead wire in the open air and leaves them till they become thoroughly entangled. The felt is then compressed and fixed upon a body of thick lead to give the requisite solidity. The inventor claims that very porous plates are thus obtained.

Electric Date Stamp.—Mr. Randall, the inventor of the electric time and date stamp, has now perfected the

combination of his stamp with the consecutive numbering machine for trial in the General Post Office. Telegram forms can, with the stamp as now arranged, be quickly stamped with exact time, the date, and the consecutive number in one simple operation.

Technical Attaches.—The Russian Government, according to the *Times* Vienna correspondent, purposes shortly to appoint technical attachés to its embassies and principal legations abroad. Their duty will be to report to the Minister of Public Works on the improvements introduced into the working of railways and telegraphs and on practical scientific discoveries generally.

Wednesbury.—At the last meeting of the Wednesbury Town Council, the town clerk reported, with regard to a resolution given notice of in favour of adopting a system of electricity, that he had issued advertisements, and had had plans prepared, but two of the firms who had notified their intention to apply for powers in Wednesbury had proceeded no further. Under the circumstances the matter was put into abeyance for another six months.

Portsmouth.—A special meeting of the Portsmouth Town Council was held on Tuesday last. They decided to apply themselves for a provisional order and notify to the Board of Trade their objection to the Portsmouth and South Hants Electric Supply Company, and to the Laing, Wharton, and Down syndicate, who had applied for the consent of the authorities. A resolution authorising the committee to proceed in obtaining the order was passed.

Mica as an Insulator.—The numerous applications of mica as an insulator give an interest to experiments of Schultze on the variation of conductivity of this material at different temperatures. The conductivity of plates of mica obtained by cleavage, increases at first with the increase of temperature: it passes to a maximum and then decreases to zero for very high temperatures. Comparative experiments between mica and glass showed that the mica was preferable.

France.—A proof that small towns of France are equally ready with the larger ones to take up the electric light if brought to their doors, is shown by the little town of Provins (Seine-et-Marne). Work will shortly be commenced on a central installation by Messrs. Garnot, and already 400 lamps have been subscribed for by the inhabitants, enough to start the installation upon a paying basis. The light may very probably also be distributed to the neighbouring villages.

Electricity on Trains.—Two trains on the St. Louis and Terre Haute Railway are being equipped with a new form of electric head lights, and if it proves successful it will be fitted on all passenger trains. The cost is about £70 each engine. On the New York and New England Railroad the trains have been fitted with an electric system instead of the alarm rope. Each carriage is fitted with a suitable push button, and the electric circuit is connected to a steam whistle on the engine.

Cattle Show at Ipswich.—The first Christmas show of the new Suffolk Fat Cattle Club was held at Ipswich on Monday and Tuesday last. The lighting of the hall was by large incandescent lamps, with an aggregate power of about 10,000 candles, for the supply of which a 30 kilo-watt dynamo was driven by the engine at Messrs. Wrinch and Son's factory. This important feature in the arrangements

was well carried out by Mr. W. B. Sisling, the Ipswich representative of Messrs. Laurence, Paris, and Scott.

Tenders for Manila.—Her Majesty's Consul at Manila, Philippine Islands, has reported to the Secretary of State for Foreign Affairs that the Municipality is desirous of obtaining tenders for the lighting of the city and suburbs by electricity instead of the present system of petroleum lamps. The total distance to be so lighted is about 36 miles, and the time for receiving proposals is limited to a period of six months, dating from the 1st ult. Further details and plans may be seen on application to the Commercial Department of the Foreign Office.

St. Petersburg.—The Belgian Consul at St. Petersburg says electric lighting makes rapid progress there as well as at Moscow, in the "palaces," administrative offices, theatres, public halls, business and private houses. In the course of this summer the installation of a new central electrical station was started at St. Petersburg, as also the laying of subterranean lines. Electric lighting has been adopted in a good part of the Vibourg quarter, at the Academy of Medicine and the Finland railway station, etc. The Second Tramway Company propose to replace its steam locomotives by electric motors.

Royal Institution.—Among the lecture arrangements at the Royal Institution before Easter, are the following: Prof. A. W. Rücker, six Christmas lectures (to juveniles) on electricity; the Right Hon. Lord Rayleigh, seven lectures on electricity and magnetism. The Friday evening meetings will begin on January 24, when a discourse will be given by Prof. Dewar on the scientific work of Joule. Succeeding discourses will probably be given by Sir Frederick Abel, Prof. J. A. Fleming, Mr. Shelford Bidwell, Prof. G. F. Fitzgerald, the Right Hon. Lord Rayleigh, and other gentlemen.

New French Cables.—The General Council of French Guiana at its last session voted an annual subvention of 80,000f. to the French Submarine Cable Company, who has engaged to lay, within one year from date of contract, a submarine cable between this colony and the French Antilles islands. The same company have obtained contracts with Martinique and Guadeloupe in place of the English company which now carries on the telegraphic communication between France and the Antilles, whose privilege expires at the end of this year for Guadeloupe, and in 1892 for Martinique.

Whitechapel.—On the principle that one arc lamp is worth two policemen, it is to be hoped that the district of Whitechapel will get its full complement of electric lighting when the provisional orders applied for are distributed. Nothing would tend more to a betterment of the lower parts of London than a generous supply of light at night, and it is probable both the local authorities and those of Scotland Yard are beginning to feel the truth of this. Bills are applied for by the London Electric and the Brush Company for supply of electricity in Whitechapel, and there is room for both in spreading the light.

Colonial Enterprise.—One of the ways to deal with colonial installations for places where native talent may not be up to the requirements of a growing undertaking, is shown by the spirited action of the directorate of the Canton Electric Light Company, who appointed a competent superintendent, ordered a complete machine shop with lathes, sharpeners, drills, and planers, with a force of 10 skilled mechanics to go out and put up the machinery.

The men are engaged on a three years' contract, fares to be paid both ways, and salaries guaranteed by bonds made by wealthy Chinamen in America.

Algeria.—A useful kind of central station is to be erected for public lighting at Mascara in Algeria. The Municipality have granted the use of the water power at Ain-Fekan, about 18 miles away from the town, free of charge. In the daytime, when not required for light, the machines at Ain-Fekan will supply power for some pumps five miles away at Sidi-Daho. In addition, the station will supply power for the manufacture of large quantities of ice, a commodity of great utility in Algiers. The concession has been given for 45 years by the Municipality, who agree themselves to pay 10,500f. a year for 150 lamps of 16 c.p.

Experimental Lighting.—At the Dartford County Court on Tuesday, Messrs. Appleton, Burbey, and Williamson, electrical engineers, of London, were sued by John Steed for £28, for the carriage of electrical appliances for fitting up The Bull's Head, Dartford, with electric light. It appears that the electric light was installed as an experiment at The Bull's Head, Dartford, by Mr. Woodford, then a traveller in the employ of the defendants, and the defendants denied liability on the ground that they did not authorise Mr. Woodford to pledge their credit. The electric lighting at The Bull's Head was done as an advertisement. The judge gave a verdict for the defendants with costs.

Ventilators for Cafes.—The use of electric ventilating fans is spreading amongst the French cafés, where the presence of large numbers of persons, all smoking vigorously, has usually made the air as dense as a London fog long before evening closes. Now, however, customers may sip their coffee or absinthe in a clear and pleasant atmosphere more harmonious to the inhabitants of sunny France. The experiment should be tried here as soon as possible, as café proprietors would, no doubt, appreciate the merry humming motor for ventilating, knife-cleaning, and other small purposes, when the electricity is laid on in mains at their doors, and a few examples can be seen in practice of its usefulness.

Leamington.—A communication was read at the Leamington Town Council from Mr. Arthur Chamberlain for the Midland Electric Light Company, saying that although they have quoted the Council for arc lighting they do not recommend it. What they advise is either the same candle-power, as at present distributed, on fewer lamp-posts in 25 or 50 c.p. lamps, if the chief object is economy; or else sun lamps of 200 or 300 c.p., similar to the one now on the Parade. Arc lamps, Mr. Chamberlain goes on to say, must have overhead wires, and the light from them, in his opinion, will certainly spoil the appearance of the shops. The letter was referred to the Watch Committee.

Aberdeen.—The Gas Committee of Aberdeen Town Council last Friday discussed the report of the deputation who recently visited several towns in England to inspect the system of electric lighting in operation there, and certain recommendations were framed on the report for the consideration of the Town Council. The proposed area of supply was defined, and of that area the authorities can only be compelled to light within two years a stipulated central portion. The larger area must be supplied within four years. It is further recommended that application should be made for both a provisional order and a Bill, the

borrowing powers to be £50,000, and the Gas Corporation funds to be the security. The cost of providing an installation for the restricted area is estimated at £20,000.

Horse Cars and Electric Traction.—A series of answers to questions upon the efficacy of electric traction as compared with horse traction, have been communicated by the president of an electric railway to the *Street Railway Gazette*. In these there is a point touched upon which may be interesting at this juncture both to tramway directors and to electric traction engineers. The question is, can the horse-car be used with an electric motor? From the experience of the electric railway company the answer is in effect: Build new cars for your electric motors. Do not convert the old horse-cars into motor-cars. You will find new cars cheaper in the end. "Most all of our cars were run as horse-cars and changed to electric motor cars. If we were going to do it again, we would buy new motor-cars, and have all our horse-cars to use as trailers, for we can say that that would have been true economy."

York.—The fact that two private companies have applied for powers to light the city of York has moved the Streets and Buildings Committee to take into consideration the question as to whether the Corporation should not supply the light itself. At the special meeting of the York City Council, convened to consider the matter, the Lord Mayor reviewed the position of electric lighting generally, mentioning that in America there were numerous companies paying 6 to 14 per cent., and that in Germany there were some hundreds of companies supplying the current commercially. The committee, he stated, had not yet gone thoroughly into the cost, but he understood that about £18,000 would be necessary at first for supplying the streets in the compulsory area. His lordship moved a formal resolution that application be made for a provisional order by the Corporation. Mr. Shoolbred was in attendance, and gave information with reference to the Bradford municipal installation. The motion was carried unanimously.

Electricity at Lincoln's Inn.—The Westinghouse station at Sardinia-street, Lincoln's-inn-fields, was handed over to the Metropolitan Electric Supply Company last Saturday, and has now begun working. The station, it will be remembered, has been completely fitted up with engines, dynamos, and apparatus by the Westinghouse Company for the supply of 25,000 lights. Three dynamos are now at work supplying current by means of partly overhead and partly underground mains. The whole of the present power has been taken up, orders for some 26,000 lamps having already been received. The light seems to be well taken up in the region of lawyers. Lincoln's Inn shows signs of the installer's activity, and lawyers' clerks are busy discussing the mysteries of switches and candle-power. The dinginess of the lawyer's office is often greatly due to the continual consumption of the carbon-producing gas, and now that the clear little incandescent lamp has invaded the premises of law, we may expect to find at last Dodson without his accompanying Fogg.

Electricity at Battersea.—While all the world and his wife are busily discussing electricity, its dangers and dear delights, when they shall have it in their houses, and why so many Americans get killed with such small apparent reason, and suchlike most interesting problems, it is pleasing to hear of the continued exertions of experts to bring home to the common mind some concrete ideas upon

electric lighting. Mr. Lant Carpenter, who is indefatigable in his exertions in this direction, commenced last Friday a series of three lectures at the Battersea Baths, with Mr. O. V. Morgan, M.P. for the district, as chairman. The lecture appears to have been well attended and thoroughly enjoyed, and it cannot be said that some definite teaching would be lost in Battersea, for we notice that even the reporter is not yet *au fait* with electrical mysteries, for in his report he remarks respecting what the lecturer no doubt gave as cost per 1,000 watts, "That whereas in 1882 the price of 1,000 volts of electric light was £2, it has now been brought down to 7s. per 1,000 volts." One might as well tell the public that water costs 1s. per pound pressure. Reporters will, in the present state of progress, find it well to study up electrical terms and facts, for through them it is that often information filters to the people.

Deputations.—It is now quite the fashion for town councillors whose technical education in the matter of electricity is suddenly called in question, to embark upon deputations to visit certain towns, of which Bradford and Taunton are two best-known examples, to inspect the electric lighting machinery and arrangements. The utility of these deputations in the matter of personal investigation of existing installations is obvious, and much real knowledge of electric lighting has been thus conveyed away. But it is apparently thought in some quarters, that investigating electric lighting problems is often too much of the nature of pleasuring to be paid for out of the rates. At any rate, at the meeting of the Southport Town Council, the ex-Mayor, Mr. Wilkinson, protested against these deputations, which, in his opinion, "were made the means of excursions, picnics, and happy times generally." His remarks called forth warm replies, and the members who had formed the deputation point out that the electric lighting question was forcing itself to the front, and would have to be dealt with by the Council before long, and that the deputation had received a large amount of valuable information while on their visit to Bradford, which would far out-balance the cost of the deputation—namely, £13; and that they had further obtained much valuable information which would be of great use in the management of their schools of science and art. And truly, the cost mentioned does not seem excessive. It would have been far more, probably, to have had an expert down from town to give his report. In this case, too, the committee would have been listening to things more or less in the air, while after an actual inspection of a working installation, as at Bradford, there is some solid basis whereon to build their ideas. Therefore, it may be considered proven that deputations to investigate electric lighting stations under proper circumstances and at moderate expense are fit and proper undertakings for town councillors to engage upon, especially if, as with the Southport councillors, they also take the opportunity of gleaning information upon art as well as science.

Cambridge.—The Cambridge Town Council held a second special meeting last week, the Mayor presiding, to consider as to obtaining a provisional order for that town. The Electric Lighting Committee reported as follows: In accordance with instructions of the Council of the 9th of November last, your committee have considered the expediency of taking the necessary steps for obtaining a provisional order under the Electric Lighting Acts, 1882-88, for the supply of electricity for public and private purposes within the borough, and beg to recommend the Council that application be made for such order forthwith." The Rev. Alderman Finch moved the adoption of the report and

recommendation. He explained that one of the objects in getting the provisional order was to prevent other companies from stepping in, and that any profit that should be made from the undertaking should be for the benefit of the public. The committee had consulted Dr. Fleming, who, among other things, was consulting engineer to the Edison Company, and that gentleman had recommended a system which was considered best for the lighting of houses, and the distribution of force, without there being any danger from the currents. That system could be extended according to the demand for electricity. Taking the expense and the revenue into account, the Council might be sure that if the scheme were carried out it would not be a losing concern; but even should it be a losing concern the loss would be very small. About £16,000 would be sufficient for the purchase of land, the erection of buildings, and the laying of wires over the area that had been selected. Supposing the Corporation did not go on with the scheme after having got the provisional order, terms could be made with others to do the work. Mr. Morley, in seconding the resolution, said Cambridge paid £3,000 a year for about 1,000 lamps and £19 for the Bray lamps, which averaged from 160 to 200 c.p. As an instance of the difference between the present system of lighting and that by electricity, he stated that for the 18 lamps in the Market-place £54 a year was paid, and the light was about 252 c.p. By the other system they could have a lamp of 2,000 c.p. put in the centre of the Market-place for £26. There would be a similar improvement in the other parts of the town if that system of lighting were adopted, and he considered that the Corporation could save £1,000 a year on the gas bill alone. The resolution was unanimously adopted.

Dundee.—A conjoined meeting of the Electric Lighting Committee of the Dundee Town Council, the Police Commission, and the Gas Commission was held last week, to consider the report of Dr. Hopkinson upon the electric lighting of Dundee. In his report Dr. Hopkinson suggests a certain list of streets to be included in the compulsory area, and recommends that when the Bill is obtained mains be at once laid in these streets. He thinks that there is no reason against including the whole area of the burgh in the permissive area, and says the committee would find sufficient protection against any out-of-the-way demands in the requirement that any consumer desiring to be supplied with the light must undertake to pay 20 per cent. on the cost of the mains required for his supply during three years. The estimated cost for plant for supplying 300,000 watts, or 5,000 lamps of 60 watts each, was given as follows: for alternating system with transformers, £24,726; the additional cost of each successive increment of 2,500 lamps would be £6,425. The annual charges for a plant of 5,000 lamps would be £5,026. 11s. 6d. A continuous-current plant on the three-wire system of distribution—the station to be within the area of supply—would be £19,047, and batteries to give 60 amperes, if used, £800. The annual charges would be £4,360. Dr. Hopkinson suggests that instead of troubling with meters at first, they should begin by charging simply by maximum supply which any consumer might take at—say £17. 10s. per unit per annum in such maximum. This would be equal to 3s. 8d. per unit if used for 1,100 hours. Customers should be shown that if burnt longer hours their lamps would deteriorate, and reasonable assurance would be obtained that customers would not wastefully consume electricity, as by so doing they would increase the cost of lamps. Compar-

ing the cost with gas, a unit of electricity would give 250 candles for an hour at a cost of 15·2d. per 1,000 candles (if used for 1,100 hours); gas will give 1,000 candles at 12·3d. in ordinary good burners. The electric lamps themselves may be taken as 3·5d. per 1,000 candle hours. The joint board held a consultation with Prof. Ewing on Friday to further consider the report. It was agreed that the Gas Commission should remain one of the parties to the proposed legislation, and that a Bill be gone on with as well as the provisional order. In order not to let the loss, if any occurred, to fall on the whole burgh, it was agreed to put in a clause giving power to assess for a deficiency in the area of supply only. The report of the committee was adopted.

Beverly and Danvers Storage Tramway.—

Although overhead lines are now plentiful in America, those running storage battery cars are not yet so general, and the opening of a new line upon the storage system is an event of some consequence. In England the storage system in most situations has immense advantages over the overhead systems, inasmuch as the exterior construction necessary for the latter often would not be tolerated in our towns, and English engineers watch with interest the progress in storage systems in other countries, while at the present busily engaged in developing their own. The new line at Beverly and Danvers, Massachusetts, is worked with six storage cars supplied by the Union Electric Car Company, of Boston. The cars are constructed in the usual way with side flaps to let down for placing the batteries the length of the car under the seats, and the battery room is arranged so that fresh sets can be easily slid in. The following particulars of this tramway were given in the *Electrical World* of November 16, with a view of the car and of the engine and battery house. The carhouse, which is also the charging station, is situated at Beverly, near the end of the track, and is 90ft. long by 40ft. wide. The batteries at the charging station are placed on lines of tables built on each side of the tracks, the top being on a level with the car floor, so that the trays, containing each 12 cells, are easily drawn from, or pushed into, the cars. The tables are connected by wires to the switchboard, and there by plugs to the charging dynamo, the switchboard being placed directly over the dynamo. There are four tables on each side of each track, each two opposite tables containing a set of 12 trays, containing altogether 138 cells to each set, each car being provided with two such sets. To insert the cells the car sides are let down and the six trays on each side are put into the car, the discharged set having first been withdrawn on the cars coming into the station. The charging plant consists of a 30 h.p. boiler and engine, and dynamo of corresponding capacity. The boiler is in a small room by itself. The switchboard is in the wall near the dynamo, and has plugs connecting the positive and the negative terminals of the dynamo to each of the eight tables by a separate plug. There are also two ammeters to show the amount of the charging current. Each set of batteries is able to run the car 40 miles with a single charge, and with the two sets a car can make 80 miles per day. It takes eight hours to charge a set fully, and the 30 h.p. plant is sufficient to charge the batteries, two sets each for six cars. The switch in each end of the car fully controls the car movement, no mechanical or hand brake being used except to hold a car when standing on an incline.

Electric Brake.—We mentioned last week the fact of the trial, on the London and North-Western Railway, of

the new Forbes and Timmis electric brake. The following details are given of the tests which were carried out on a stretch of the London and Birmingham main line, between Adderley Park and Stechford. An old-type coach, with four wheels only, was fitted with the apparatus. In one of the compartments was a battery of 17 storage cells. The break-handle is simply a switch, to complete the circuit to the magnetic iron discs of the brake, with a resistance regulating the strength of current. After the 8.40 London train had left Adderley Park Station a large goods engine was attached to the coach, to which an ordinary brake-van was linked in case of emergency. The line between Adderley Park and Stechford is in every way suited for such a trial, there being a straight run for nearly a mile and a half, over an almost level line. On this portion of the track, a distance of a quarter of a mile was marked off by fog-signals, on account of the mist, and a sufficient space being allowed for the driver to get up speed, the signal to start was given. At the end of the distance the coaches were slipped, and although running, as was afterwards ascertained, at the speed of 30 miles an hour, were brought to a standstill in about 200 yards. This was considered to be a very good trial, inasmuch as the rear van was running free, and would necessarily impel the first coach over the lines, coated as they were with a film of ice. Two or three other trials were made with almost precisely similar results, and Stechford was then reached. As it had been demonstrated that the electric brake was effective Inspector Carr permitted the guard's van to be detached, and trials were made with the single coach. The results arrived at were, of course, of a more satisfactory character. A half-mile run was tried, and the coach slipped whilst travelling at the rate of 42 miles an hour. The brake being instantly applied brought the coach to a standstill in 150 yards. No doubt that distance would have been considerably diminished but for the fact that the wheels, being instantly locked, glided along the glazed surface. It might naturally be expected that the sudden application of the brake would have manifested itself in an unpleasant manner to the occupants of the coach; but the application was only slightly appreciable by the nine occupants. This is one of the great advantages claimed for the new brake, and is attributable probably to the fact that the brake is in no way connected with the body of the carriage, the magnetic discs being kept in position by stays running from one to the other. The trial lasted for about three hours, the best result obtained being the stopping of the car in 60 yards, when travelling at 30 miles an hour. The experiments were considered by the company's officials to be highly satisfactory. A significant fact in connection with the trial was the distance the engine ran before brought to a standstill by an ordinary hand-brake, at least five or six hundred yards being required. With a steam-brake a much less distance would have been required, but it is very doubtful whether the locomotive would have been brought to a standstill nearly as quickly as was the coach with the electric brake.

Richmond.—The Electric Lighting Committee of Richmond-on-Thames have been actively discussing the lighting of the town, and at Tuesday's meeting of the Richmond Vestry presented the following interesting report: The committee beg to report that since their reappointment they have visited the following installations, viz.: (1) The Kensington central electric lighting station of the House-to-House Electric Light Supply Company, Limited; (2)

the Pall Mall Company electric lighting works; (3) the Sardinia-street, Lincoln's-inn-fields, installation; (4) the Whitehall installation; (5) the Paddington installation; and (6) the works of the Chelsea Electricity Supply Company, Limited. The committee have carefully examined the different systems of distribution which in each case have been adopted. Incandescent electric lighting of large buildings containing their own plant, and steam vessels, has from the first been a commercial success, but the distribution of electricity over large areas, so as to provide the public with supply from a central station, has proved a more difficult problem and taken time to solve. The fact that three companies—viz., the Brush Electrical Engineering Company, Limited, Messrs. Latimer Clarke, Muirhead, and Co., Limited, and the South of England House-to-House Electricity Company, Limited—have now given the statutory notices of intended application to the Board of Trade for provisional orders to supply the electric light to Richmond, seems to afford evidence that the distribution can now be effected with satisfactory financial results. From information obtained by the committee, it appears that the Brush Company propose to work with low-tension continuous current and storage batteries; that Messrs. Latimer Clarke, Muirhead, and Co. would also work on a somewhat similar system, but partially with storage batteries; and that the South of England House-to-House Company would work with high-tension alternating current with converters. The committee are not in favour of the latter system, though it has advantages of economy where greater distances have to be covered. The committee would observe that the Vestry, having a provisional order under the Electric Lighting Acts, are enabled to contract with any company or persons for the execution and maintenance of the works needed for the purpose of the supply of electric lighting to the town—a power which the committee feel it advisable should be retained by the local authority as preserving to them the right of prohibiting undue interference with the public streets, footpaths, etc., and the committee are advised that under such contract the Vestry can insert clauses against default in supply by the contractor, whilst any company obtaining a provisional order under the new Act would obtain a monopoly for 42 years. The committee have consulted Mr. Shoolbred, C.E. (with whose assistance the Vestry's provisional order was obtained), and as they are now in communication with responsible parties who have offered to supply Richmond with the electric light under the Vestry's provisional order with power of purchase by the local authority after a term of years, with one of whom the committee think satisfactory arrangements could be made for at once providing an installation in the town, recommend the Vestry not to consent to a provisional order being granted to any outside company, but to authorise the committee to negotiate with some company or person willing to contract with the Vestry for the supply of electric lighting to Richmond at the exclusive cost of such company and report to the Vestry thereon; also that the vestry clerk do inform the Board of Trade of this resolution. Mr. Hilditch, who read the report, said the committee had held many meetings, and he was happy to say they were unanimous. Mr. Robinson seconded the motion, which was adopted. Richmond is one of those towns which obtained its provisional order in 1883, and up to the present nothing has been done with it. There seems to be now a distinct intention to proceed to practical measures in the immediate future.

THE MAGNETIC CIRCUIT.

From the earliest time up to now the schoolmen have shrouded the science of electricity in obscurity. Ohm, indeed, gave us a formula or demonstrated a law which is the groundwork of what has been termed conductive electricity. Till quite recently, while most acknowledged a conductive circuit, few understood about an inductive circuit, and fewer still a magnetic circuit.

Ohm's formula $C = \frac{E}{R}$ is now accepted without question for one of these circuits, but it was not and is not recognised that a similar formula rules for the magnetic circuit. Suppose C be replaced by $M F$, magnetic effect, magnetic flow, or simply magnetism, and E by magnetic pressure, P , and let R represent the resistance of the magnetic circuit, then $F = \frac{P}{R}$.

Consider for a moment the simple case of an electro-magnet. A wire is wound round an iron core. The current sent through that wire exerts magnetic pressure, P , and the resultant magnetism, magnetic effect, or magnetic flow, F is directly proportional to that pressure. If again, with the same current and the same core, you halve the magnetic resistance of the circuit, you double the magnetic effect, or F is inversely as R .

Oh, but, say the schoolmen and all their followers, you can only get so many lines of force through unit section of area. True, so you can only get so much current through unit section of conductor; but that has nothing to do with $C = \frac{E}{R}$, nor has supersaturation anything to do with

$F = \frac{P}{R}$. Further, just as instruments are made to mea-

sure C , E , and R , so instruments can be made to measure F , P , and R . There is no difficulty in the matter, but there is an immense amount of inertia to accept new ideas, or to accept ideas that do not come from the schoolmen. You cannot get a conductive circuit of no resistance; so you cannot get a magnetic circuit of no resistance. Perhaps the magnetic analogue to the well-known short circuit is a complete ring. Where all the lines of force go through the ring, and none are scattered about outside, you can then get the maximum number of lines of force, or the maximum magnetic flow, past which you cannot go. Perhaps some of the searchers after units will give us practical units to correspond with volt, ampere, and ohm in Ohm's formula.

NEW YORK NOTES.

(FROM OUR SPECIAL CORRESPONDENT.)

Mr. Westinghouse's Reply to Mr. Edison.
A Good Case for the Alternating System.
The Chicago Electric Club Retracts.
The Board of Electrical Control.—Broadway Blocked.
Another Death from Electricity.—A Remarkable Accident.
An "Expert's" Inexpertness.
The Boston Fire.
Making a Scapegoat of the Wires.
A Hero of the Key.
The Edison Patent Sustained in Canada.
The Fourth Avenue Cars Running Again.
Wonderful Effects of an Injunction.
Another Big Combine.—Mr. Wanamaker's Pet Hobby.

NEW YORK, December 6, 1889.

In the current number of the *North American Review*, Mr. George Westinghouse, jun., makes a spirited "Reply to Mr. Edison." Mr. Westinghouse refutes many of Mr. Edison's statements as to the relative safety of the low-pressure continuous and high-tension alternating system, and makes several good points in favour of the latter. "Any plan of distribution," he says, "that involves the meshing of the mains underneath the streets with all the house wires connected thereto is regarded by the majority of competent electrical engineers as in many respects radically defective—so defective, in fact, that, unless the use of alternating currents can be prohibited, it seems destined to be wholly supplanted by the more scientific, and in all respects

(so far as concerns the users or occupants of buildings) far safer, inductive system. Apparently sensible of this, Mr. Edison does not hesitate to say, "My personal desire would be to prohibit entirely the use of alternating currents." Mr. Westinghouse goes on to point out that the Edison system is not nearly so harmless as has been suggested, and says that anybody can obtain a surprising demonstration of the energy conveyed through the wires by connecting a tin pan to one, and a gridiron to the other, by which means a substantial beef-steak can be cooked to a turn in two minutes. "With even less than 100 volts it is painful beyond endurance to press firmly with both hands on the brushes or any bright brasswork of the dynamo, or to grasp any metal connected with the wires." After discussing the high-tension continuous and high-tension semi-continuous or pulsatory currents, Mr. Westinghouse says: "The reader of Mr. Edison's article who is unfamiliar with the alternating system of distribution would naturally infer that in practice the same voltage is carried on the house wires as on the mains, as in the Edison system; but such is never the case under any circumstances. In this complete disconnection of the street and house wires is found the reason of the positive safety both to life and property enjoyed by users of the alternating system. It is one of the great advantages of this system that it admits of the use of high voltages for the street mains, and of wholly separate and independent currents, with absolutely safe voltage, for all wires within buildings, a condition which is infallibly secured and maintained by converters or transformers, located in or near each building. . . . It seems possible that the time is not far distant when the regulations governing the distribution of electricity will rigidly prohibit direct electrical connection between the street wires and the local service wires inside houses, thereby excluding from dwelling-places all the dangerous effects possible to ensue from accidental leakages in the underground system."

Mr. Westinghouse next dwells on the dangers and defects to which the Edison system of underground conductors is subject, and indicates that the cables used for the alternating system are far more practical and suffer much less from leakage owing to the much smaller number of joints. "As to the accidents from electric currents, the records of deaths in the city of New York show that there were killed by street-cars, during the year 1888, 64 persons; by omnibuses and waggons, 55; and by illuminating gas, 23; making the number killed by the electric current (five) insignificant compared with the deaths from any of the other causes named. The placing of the wires underground would eliminate many of the causes of accidents from electric currents, and they may all be prevented by the employment of reasonable and well understood safeguards. Mr. Edison's statement that placing the wires underground will, instead of diminishing, increase the danger to life, is little less than amazing, at least, when considered in connection with his advocacy of his own underground system. . . . Inasmuch as Mr. Edison's arguments against underground wires generally are equally applicable to his own system, it would seem, logically, that, if his views are to prevail, all electric wires must cease to serve the public. The experience of the cities of Chicago and Philadelphia in the use of underground cables for high-tension currents—to say nothing of the large number of cables laid underground in Rome, Berlin, Milan, and in other cities—indicates that the success of properly-constructed underground systems, whether for currents of high or low tension, has been established beyond question."

After some further discussion of the relative merits of the different systems in regards to distribution, flexibility, safety to the consumer, and an incidental reference of the recent appeal of the local Edison companies for an arc light system and higher tension for domestic lighting, Mr. Westinghouse winds up as follows: "In conclusion, it is worthy of note that for three years past the purchasers of apparatus for electric lighting, who are at perfect liberty to buy from any company, have, for the most part, preferred to use the alternating system, so that to-day the extension of that system for central station incandescent lighting is

at least five times as great as that of the direct current. If the opinion of these persons, who can have no interest except to purchase that which they believe to be the best, is of any value, then the alternating system has been demonstrated to be the one which can give to the public that which they so much desire—a safe, cheap, efficient, and universally applicable system of incandescent electric lighting."

At the last meeting of the Chicago Electric Club Mr. Sunny proposed that the resolution adopted after the discussion on his paper, in which Mr. Edison's article in the *North American Review* was condemned, be struck off the minutes, and further proposed that a clause be added to the constitution enacting that the club should not take part by vote in "trade controversies" unless in extreme cases and by unanimous vote of the entire membership.

The emphatic condemnation of the Board of Electrical Control conveyed in the verdict of the grand jury has been most favourably received both by the technical and general press, as most of the papers have been sounding the same note for a long time past. It appears that there exists a deadlock between the Mayor and the permanent members of the Board. No meeting has taken place since those held immediately after the death of Feeks, although events have occurred since then which would amply justify several meetings. Upon the Mayor, however, as president, devolves the initiative in summoning his worthy *confrères* to hold a meeting, and as the Mayor and the *confrères* are just now decidedly at loggerheads on the subway question no meetings are held. In this way the Mayor is enabled to preserve his temper, or vent it in other directions, and the public is spared the perusal of the meaningless twaddle in which the erudite commissioners habitually indulge.

Just now everybody is abusing both the Board and the Subway Company in the heartiest manner possible. For nearly a fortnight the lower part of Broadway, where the concentration of trams and heavy traffic of all kinds is greater than in any other part of the city, has been in a state of siege consequent upon the tearing up of about one-third of the roadway by the Subway Company. The street is torn up from the sidewalk right to the very edge of the tramway tracks, leaving only one side of the street free for general traffic. The cross traffic is so great and the trams follow each other so closely that blocks are of frequent occurrence; almost every afternoon for days past the traffic has been entirely stopped for a considerable period by an apparently inextricable tangle of vehicles extending for about a quarter of a mile. As Broadway is the main artery of the business district, and is intersected by numbers of streets along which the traffic is very heavy, the annoyance to carriers and passengers, the danger to pedestrians, and the losses suffered by merchants have been very considerable, and complaints against the Subway Company as to the slow progress of the work are both loud and deep. A touch of frost this week caused a fresh note of alarm to be sounded, as if severe cold were to set in the blockade might be indefinitely prolonged.

Another death from electricity took place in New York last Saturday night. The accident came about in a very peculiar manner, and certainly reveals culpable negligence on the part of the electric light company. The clerks employed in a fancy goods shop were preparing to close the place for the night, and two of them started to carry a showcase that had been standing on the pavement inside the shop. The upper part of the showcase was of glass held together by a metal framework, which terminated in a point at the top. As the foremost clerk stepped on the iron grating in front of the door the top of the metal framework struck against an arc lamp hanging above, and at the same moment the unfortunate man gave a shriek and fell backwards, expiring a few minutes after. It appears, that for the purpose of steadying the showcase, he had grasped the metal framework, and this, coming in contact with the lower carbon of the lamp while he was standing on the iron grating, caused him to receive a powerful shock, resulting in his death, while his companion remained unhurt. The circuit to which the lamp belongs is an underground one, and this accident does not make a very good showing for the underground work. The coroner appointed a doctor

and an "electrical expert" to examine the dangerous lamp. It appears that the bottom of the carbon-holder was worn away, and the lower carbon protruded about 2 in. below the socket; the lamp was hung only 8 ft. above the ground instead of 10 ft., as required by law. It is said that tests made by the investigators showed a difference of potential between the framework of the lamp and the ground of about 3,000 volts. The "electrical expert," who, by the way, was a well-known gentleman named Heinrich, narrowly escaped coming to grief; with so much zeal and so little expertness did he conduct his experiments that he received a severe shock, burning his hand badly, and only escaped more serious consequences because the sudden start he gave caused him to drop the wire. The inquest on the death of Harris will be held early next week, and it is the intention of the coroner to sift the matter to the bottom, and, if possible, procure the indictment of the company owning the fatal lamp.

The Fire Marshal of Boston is conducting an investigation with a view of discovering the cause of the recent great conflagration in that city. It has been stated in the daily papers that a cross between electric wires was the origin of the fire, and various employes of electrical companies have been examined in order to sift this theory. Nothing has transpired, however, which bears out such a conclusion. The only fact elicited in support of the probability of such an origin is that the Boston Electric Time Clock Company had its central office in the building where the fire originated, and that some of the company's clocks which were on circuits starting from this building were burned out a short time before the fire was discovered. The Boston Electric Light Company state that none of their wires were in the building where the fire started, so that the cross which resulted in the burning out of the clocks may have been caused by the fire instead of being the cause of it. Immediately after the outbreak of the fire the Boston Electric Light Company shut down their entire plant, and notified the firemen that they need have no fear of working among the wires, as they were all "dead." The New England Telephone Company had about 200 overhead wires disabled by the fire; but with great promptitude all the broken-down circuits were cut into spare underground cables, and by 10 o'clock on the morning after the fire all the interruptions were made good.

A few days after the Boston fire another and more disastrous one, as far as loss of life is concerned, occurred in Minneapolis. The fire broke out in the third floor of a seven-storey building and quickly worked its way up, cutting off all means of escape to those above. One of these was a telegraph operator named Igoo, who was working the Associated Press wire in an office on the top floor. When the fire was discovered he telegraphed the news to all the other operators on his circuit and calmly went on with his work. After a short time he telegraphed that all others had left the building and he must make his escape, but his devotion to his duty proved fatal, as the poor fellow's escape was cut off, and in endeavouring to let himself down by the wires to the next building he fell and was killed. The mass of wires surrounding the burning building interfered greatly with the work of the firemen, and the jury call attention to this in their verdict following the inquest into the deaths of the victims of the fire, and they recommended that all wires in the city be placed underground.

The Edison incandescent lamp patent has been sustained in Canada. Last February the Deputy Commissioner of Patents rendered a decision annulling the patent, the petition being made by the Royal Electric Company, of Montreal. A doubt having arisen as to the jurisdiction of the commissioner, it was decided that the case should be commenced *de novo*. A re-hearing accordingly took place before the Hon. John Carling, minister of agriculture, Sir John Thompson, minister of justice, sitting with him. The petition of the Royal Electric Company was dismissed, and the Edison patent declared valid. Under the Canadian statute there is no appeal from this decision.

The Fourth-avenue electric cars have resumed work with new batteries made under the process indicated by the judge who decided the recent injunction case against the Julien Company. The new batteries are stated by the

company to be vastly superior to the old ones, a marked increase of efficiency being noted. The officials of the company express themselves as "more than surprised" at the extraordinary results attained; altogether the injunction would seem to have been a blessing in disguise.

Another big electrical combine has taken place in the absorption of the Sprague Electric Railway and Motor Company by the Edison General Electric Company. The construction work for the Sprague Company has long been done at the Edison Machine Works, and the companies have been closely allied, Mr. E. H. Johnson (now the president of the Sprague Company) having formerly been president of the Edison Electric Lighting Company. Mr. Johnson is a firm believer in the great future that awaits the electric motor, and thinks that the Edison stations are rather electric power stations than electric lighting stations. He has always held such views, and took an interest in the evolution of the Sprague motor and the formation of the Sprague Company, which enterprise he carried on in friendly alliance with the Edison electric light interest, with the constant idea of sooner or later effecting a union between these two industries. Now that he has effected it, Mr. Johnson intends to retire from active connection with the enterprise in order to devote his attention to private matters. Otherwise, the Sprague organisation will be maintained as it now exists, and no change will occur in its business arrangements. The combine is effected by exchanging Edison stock for Sprague stock, share for share, and a beautifully simple method of arranging matters it seems to be.

Postmaster-General Wanamaker is extremely anxious to try his hand at the telegraph business, and his report to the president submits a scheme for a limited post and telegraph service. He thinks that a demand exists for cheap telegraphic service, and that ladies would be large customers if windows for the reception of messages were opened at the post-offices where they are accustomed to go.

LONDON COUNTY COUNCIL AND OVERHEAD WIRES.

It is stated by the *Times* that amongst other Bills prepared to be submitted to Parliament, the London County Council has prepared one on subways and overhead wires. It is customary, we understand, that all these Bills have to be read first time in the House of Commons before they are issued to the public, and it may be as well, preparatory to the publication of this Bill, to recall the report of the Select Committee upon telephone, telegraph, and other wires, which embodies the law at the present time. It was as follows:

Your committee have heard evidence from the Post Office, the telephone companies, the various local authorities of the metropolis, the corporations of some of the leading provincial towns, and private owners and occupiers.

After careful consideration of this evidence, your committee have come to the conclusion that the risk of danger to the public from overhead wires has been very greatly exaggerated.

The accidents which have been proved in evidence have been few and insignificant. In the most important instance the fatal result was due, not to the breaking of the telegraph wire, but to a well-meant attempt by a member of the public to replace it.

At the same time, your committee are of opinion that the probable development of the telephonic system makes it desirable that there should be some change in the law relating to control over wires, with a view to their better supervision.

The present state of the law is, briefly, this: The Postmaster-General works under the powers of the Telegraph Acts, 1863 to 1878. The Acts of 1863 and 1878 give the powers. The Act of 1869 gives the Postmaster-General his monopoly. The Act of 1868 gives certain powers respecting railways. The powers may be conveniently divided thus:

1. *Overground along Roads.*—Consent of road authority first to be obtained. If refused there is an appeal to a stipendiary magistrate or to a county court judge, and a further appeal by either party to the Railway Commissioners. Permission having been obtained, the Postmaster-General: (1) *In towns* proceeds without further consents, but subject to various limitations, including a provision that he must not place a post within 10 yards of a dwelling-house without consent of occupier; (2) *in country* he has to obtain various other consents of adjoining owners, to publish notices, etc., with appeals against refusal,

etc., and to take other proceedings involving possible long delays. There is also a similar provision against placing a pole within 10 yards of a dwelling-house without consent of occupier, as in towns.

2. *Underground along Roads.*—(1) *In country* the Postmaster-General can proceed, subject to certain notices and regulations, without any consent; (2) *in towns* he must obtain the consent of the road authority, with appeals against refusal as above, and then he can proceed, subject to notices and regulations.

3. *Overground by Attachments to Property.*—The Postmaster-General has no powers except in towns, where, having obtained consent of road authority, he may pass wires over buildings or lands (not being building land, or gardens, or pleasure-grounds) adjoining or near to the street, subject to notices and restrictions. He has no power of making attachments to private property.

These powers are inherited from the telegraph companies, the right of appeal against a refusal by the road authority or by a private owner being given by the Act of 1878. Neither the telephone companies nor any other persons or companies have any statutory powers. They carry on their business only as licensees of the Postmaster-General, and are governed merely by the general law. They have no power to make attachments to or to run wires over private property. It has, however, been decided by the Court of Appeal that the road authority has no power to interfere with wires passing over roads, unless they interfere with the user of the road, or are a source of danger.

Certain corporations have recently obtained local Acts, giving them authority to deal with wires. From all these (10 in number) the Postmaster-General is excepted. In two cases (Nottingham and Chester) the local authority has an absolute veto on overground or underground wires in or over streets. In four cases (Heywood, Dewsbury, West Derby, and Bolton) there is an appeal from this veto to a court of summary jurisdiction. In four cases (Liverpool, Manchester, Birkenhead, and Croydon) the Corporation may make by-laws on the subject, which must, however, be approved by the Board of Trade. Two distinct principles are involved in these Acts.

(a.) *In Heywood, etc.*—It is a *judicial* question. The question is between the local authority and the company erecting the wires, and disputes are referred to the county court judge.

(b.) *In Liverpool, etc.*—It is an *administrative* question. By-laws for the regulation of the wires are made, and the local authority administers them.

Having regard to this state of the law, and to the necessity for some alterations in it, your committee would submit the following suggestions:

Regarding the free development and use of the telephonic system as essential to the public convenience, your committee cannot recommend any course which would materially hamper its extension. The system of public telephone exchanges, whereby persons at considerable distances apart may converse freely the one with the other, is a great public convenience. The number of subscribers to these exchanges is already over 12,000; the number of messages sent during the year was over 41,000,000; and the average cost per message was less than one penny. This system is daily growing, now that increased facilities have been given for the purpose by the Postmaster-General. In London alone the number of subscribers is nearly 4,000, but the capability of development may be estimated by the fact that, according to the evidence of Mr. Preece (electrician to the Post Office), there are more subscribers to the telephone system in New York and its neighbourhood than in the whole United Kingdom, notwithstanding that the charge in New York is about double what it is here. The annual number of messages in London is over 15,000,000.

The companies have recently proposed to place every post-office in the London district upon their exchange system, upon any reasonable terms to which the Postmaster-General may agree, so as to afford the entire public of London the means of instantly conversing with subscribers to the system, and similar offers have been made by other companies for towns in their districts; and the committee therefore recommend that the erection of overhead wires should be continued, subject to proper regulation and supervision.

In order to obviate the delays and difficulties experienced by the Post Office in laying down wires, especially along roads, it is proposed that the Postmaster-General should be authorised to give notice of the intention to erect any telegraph line before (if he thinks fit) instead of after obtaining the consent of the road authority. Such notice to be advertised and posted in the street affected in towns, and in the country to be also left as at present, at any dwelling-house within 50ft. of the road, and to be served on the occupier of any park or pleasure ground.

All persons, including the road authority, desiring to object to the mode in which the proposed line is to be carried, should send in their objections to the Postmaster-General within a stated period, say three weeks, and all objections not so sent in should be barred.

All objections so made should be referred to a competent tribunal, which should be empowered to make an order authorising the erection of the line on such conditions as may be deemed just, and to make such order as it may think fit as to the costs occasioned by the several objections.

This tribunal might conveniently be the county court judge (sitting as an arbitrator) of the district within which the property in respect of which the objection is made is situate. The county court judge should be substituted for the police magistrate, where the jurisdiction is given at present to the latter tribunal.

If an appeal from the county court judge is thought necessary, this might properly lie to the Railway Commissioners, as at present; but the Postmaster-General should be authorised to proceed with the erection of his line if the appeal to the Railway Commissioners is not prosecuted within a fixed period (say one month) of the decision of the county court judge.

The Postmaster-General should be allowed to make attachments to private property with the consent of the occupier, and should not be obliged, as at present, to obtain the consent of the leasee and owner, subject, however, to the condition that consent of the occupier held good during the term of his occupation only.

The provisions of the existing Acts inconsistent with the foregoing suggestions should be repealed, and especially the provision requiring the Postmaster-General to obtain the consent of the occupier of every dwelling-house within 30ft. of a pole.

The telephone companies occupy a position somewhat similar to that occupied by the old telegraph companies, save that they are acting under the license of the Postmaster-General, to whom they pay a large royalty, estimated at present at the rate of £20,000 a year, and liberty to increase if they are given reasonable facilities for the service of the public. It is proposed by the representatives of the Post Office, and your committee recommend, that the licenses of the Post Office should have the same powers with regard to the running of their wires as the Postmaster-General; subject, however, to the proviso that the wires of the company should not be permitted to interfere with those required for the general public telegraphic service by the Postmaster-General.

Your committee are of opinion that, under proper regulations, permission should be given to pass wires over property without the owners or occupiers having the right of prohibition; but this facility should confer upon those enjoying it no vested interest or easement, and should not relieve them from any claim for damage occasioned by them.

They should be required to remove or alter their wires if the premises were about to be raised, or for any other good cause shown; and the occupier should be given an appeal to the local authority to order the removal of the wire, in case he could show special circumstances which caused the same to be an injury to him or to his property.

With regard to attachments, these can only now be made either by the Postmaster-General or by any person else, with the consent of the occupier and owner. In certain cases it may happen that it is impossible to obtain access to premises for the purpose of connecting them with the general public telephonic system, owing to the refusal of an individual to permit an attachment.

It was given in evidence that many of the inhabitants of the Inner Temple are desirous of being connected with the telephone exchange, but that the telephone company is unable to obtain permission to run wires for them. It was also given in evidence that a similar prohibition has been exercised in the case of Covent Garden.

Your committee think that in special cases, where it could be proved to the satisfaction of the local authority on investigating the whole circumstances, that certain individuals or certain districts were debarred from the public convenience of telephonic communication owing to such refusal, the local authority should be authorised to give permission to attach wires to premises under suitable regulations and on payment of such compensation as the local authority may think just.

By-laws for the regulation of all wires, as to substance, length of span, durability, and other matters, and for the identification and inspection, should be made for the whole of London by the Metropolitan Board of Works, for provincial towns by the corporation, for rural districts by the local authority, in each case subject to the sanction of the Board of Trade. In London the enforcement of these by-laws should be entrusted to the Corporation of the City, and to the vestries and district boards.

For the protection of the public it is necessary that there should be a ready means of dealing with every wire.

For this purpose every wire should be identified, and the by-laws should provide for the best method of identification, by registration or otherwise, and for the removal of all ownerless wires.

Your committee believe that such regulations as they have recommended will be abundantly sufficient to protect the public from inconvenience and danger, however wide may be the extension of the telephonic system.

At the same time they believe that nothing which they have

recommended will impede the natural development of an invention the great and increasing utility of which they fully recognise.

THE COLUMN PRINTING TELEGRAPH MACHINE.

The first, and probably the final, stage of the opposition of the Exchange Telegraph Company to the patents of the column printing telegraph instrument came before the Comptroller of Patents at the Law Courts on the 16th inst. This instrument has been patented by Messrs. Moore and Wright, and is owned by the Column Printing Telegraph Syndicate, Limited, which, by an agreement with the Central News Agency, can supply information of all kinds to clubs, newspapers, exchanges, news rooms, and so forth. Of course the intention of the promoters of the new machine is that it shall supersede the "tape," as it will deliver its news in the form of a printed page.

Mr. Moulton, Q.C., appeared for the Column Printing Syndicate. He pointed out that Messrs. Moore and Wright applied for the seal to their patent, which is numbered 10,437 of 1888. Opposition to this was offered by a Mr. Higgins, but Mr. Moore had answered his statutory declaration, and no evidence had been put forward in reply. Mr. Graham, acting for the Exchange Telegraph Company, said a declaration had been filed. Mr. Moulton remarked he had not heard of any, but the ground of the opposition was that the inventions for which the patent is sought had been patented in patents of prior date. He considered the opposition was radically bad on all grounds. The best way to show the groundlessness of the opposition was to take the declaration of the other side and go through the objections serialim. This the learned gentleman did with great care and cogency, until he had shown that everyone of Mr. Higgins's objections could not be maintained for a moment. Mr. Graham's task was very simple; it consisted merely of abandoning the objections, with one exception, which related to the return of the type-wheel at the end of a line, which is arranged by the use of a strong current, which Mr. Graham remarked might be taken as meaning "longer current."

On Mr. Moulton's agreeing to the clause referring to this being worded as below all opposition was withdrawn: "A printing telegraph for printing in line, in which the commencement of a new line is effectuated by an electrical magnet energised by the reception of a stronger current than that used for printing, so as to actuate an escapement mechanism." Mr. Moulton pointed out to the Comptroller that this was only the same thing, but in a little different form.

The Exchange Telegraph Company can still proceed for an infringement, but whether they would have the temerity to do so after their fiasco before the Comptroller is doubtful. The column printer has been at work in newspaper offices for a long time. The Exchange Telegraph Company have not only been aware of this, but they have seen the machine at work, and narrowly observed what it is capable of doing. Perhaps the Exchange Company have already recognised the futility of taking any steps, for they have not up the present acted upon the threat put forward in their advertisements in the newspapers to the effect that they will prosecute anyone selling or using column printing machines which are infringements of their patents. As no such steps have been taken, the inference is clear.

COMPANIES' MEETINGS.

MAXIM-WESTON ELECTRIC.

A meeting of the Maxim-Weston Electric Company, Limited, was held on 12th inst. at the Cannon-street Hotel, E.C., Mr. John Marks (one of the liquidators) being voted to the chair.

The Chairman said the only question of interest on which he would like to say something was one on which his mouth was necessarily closed—he referred to the litigation now going on between Mr. Hugh Watt and the Company on the one hand, and the liquidators and Mr. Watt on the other hand. In regard to other matters, they would have seen that they had been successful in the dispute with Mr. Watt's claim for 7,376 shares. As the report intimated, they disputed Mr. Watt's right, and maintained that he was entitled to some 3,000 less than the number of shares he claimed, and he (the Chairman) was happy to say that they succeeded in upholding their contention before the arbitrator, Mr. Whinney, to whom the matter was referred.

Sir H. Hoare asked whether it would not be in the interests of the shareholders to have a full statement of the position of the Company before them.

The Solicitor pointed out that the meeting was called simply to deal with the report of the liquidators, and the matter which Sir H. Hoare had raised had reference to the new company, which could not be dealt with by the present meeting.

Mr. John Newton then proposed that the report which had been read should be printed and circulated amongst the shareholders of the old company.

A Shareholder seconded the motion, which, after some discussion, was carried.

On the motion of Sir H. Hoare, seconded by Mr. John Newton, it was agreed to pay the liquidators a sum of 150 guineas on account of their remuneration in connection with the liquidation.

The representatives of the Press were then desired to withdraw, and certain matters were discussed in private.

THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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THE MORAL OF THE TALE.

Is there any question of very great importance agitating the electrical industry at the close of this year of grace? We fancy there is no such question, although some people might contend otherwise. There are, it is true, some important experiments to be performed, but the result of these will be a feature of 1890, rather than of 1889. One of our gas contemporaries has had the hardihood to twit the supporters of electricity with the fact that they have not paraded their hobby as efficacious against gas strikes. Probably the intention was to be satirical, though it would take a better instrument than the best microscope to tell where the satire comes in. Electrical engineers are not so idiotic as to suppose that electricity is to be looked upon as an alternative when there happens to be a row between gasmen and masters, and when the production in gas is partly diminished for a whole week. It may be a consolation to our contemporary to know that electrical engineers hope for no mean advantage because of trade disputes. They are convinced of the value of the light they propose to give, its salubrity and its adaptability for all persons and places, and urge its adoption because it is better than the light now generally used. It may even be a greater consolation to be told that the electrical folk could not do better than the gas folk in face of a great strike. We are as dependent upon coal supply as a gas works, for after all is said and done, both gas and electric light can be traced back to the coal delivered from the bowels of the earth. Coal is wanted just as much for the engine furnace as for the gas retort. However, we think Manchester and the South Metropolitan will teach the men a lesson they will not easily forget, and it is to be hoped that never again will there be an attempt to paralyse the business of a town or district by an attempt to deprive it of its artificial light. One lesson electrical engineers should learn, and that as soon as possible. When several companies are engaged in lighting adjacent districts, the time will come when, from some cause or other, one of the companies will be in difficulties. If the pressure adopted was the same in each district, and if the system adopted was the same, whether alternate or constant, or, indeed, if the arrangements were approximately the same, assistance might be given to one station by several of its neighbours, and so disaster averted. When one company, like the Metropolitan, for example, has a number of stations, some method of temporary exchange or linkage will almost certainly be necessary. Take the stations as they now exist or are in process of installation. Whitehall is complete. It is, we are told, doing more work than it ought to be doing. This from the consumer's rather than from the producer's point of view. It is certain, moreover, that in

process of time a much larger number of lamps will be wanted in the vicinity of the station, and so places further away would preferably be put upon some other circuit. Sardinia-street is the next station, and here a different system is adopted; so that if it is found desirable to transfer the outlying work of Whitehall to Sardinia-street, it will not be so easy as it would be if the stations were working on the same lines, nor would it be so easy for Sardinia-street to take up the whole load of Whitehall if required. The same thing applies if the London Electric were ever desirous of giving assistance to the Metropolitan, or *vice versa*.

This seems to be the lesson of the gas strike. If, in certain places, the mains of the South Metropolitan could have been put into communication with the mains of other companies, the latter supplying through a meter at a price to be mutually agreed upon by the companies before the time of the trouble, the danger of "no light" would be considerably lessened. It is useless to consider such things at the moment of difficulty. They must be thought out and all arrangements made beforehand. This forethought is what we urge in electric lighting. While we are on the subject of "morals" to be learned from fables relating to gas lighting, another may be referred to as destined to play its part in history. All gas mains leak. The soil is, in many places, so impregnated with gas that, on being opened out, the light of a match or any other light will cause an explosion. This gas will get to the electric light mains, and in one or two instances, it is said, it has done so already, and explosions have been the result. We all know such explosions are said to be as common in America as blackberries are on brambles. Some people have gone blackberry gathering and found none on the brambles, so, perhaps, many of these explosions are hearsay explosions. At any rate, there ought to be no possibility of such a thing. Two things, at least, are required in an explosion—first, an explosive; secondly, a light. Knowing this, the remedy is simple. Don't let the explosive get to the point where a light may be, and don't let a light be found at any point where an explosive may be. In other words, pay the greatest attention to insulation where gas can percolate, and do not imagine that, because gas is somewhat of an insulator, naked wires or insufficiently protected wires may be tolerated. It is not an electrical difficulty which has to be met, but one of another character. The man who is soaked with electricity is not the man to be trusted with much responsible work in connection therewith. He will be so filled with his own knowledge and the vastness of his one subject, that the difficulties of "another character" will never occur to him till his pretty designs are blown sky-high, owing to something which was originally not thought of. With over-

head wires there is no danger from gas percolation and explosion, and, therefore, as the English custom is against overhead wires, it behoves all to see that dangers underground are not disregarded. It almost passes the bounds of comprehension how carelessness in this direction is possible, especially as it is well known how closely every piece of work is watched, and how great a matter any little failure is made by those interested in gas interests. It may be well to refer here to a laughable assumption, which has "fetched" not only the daily but some of the technical papers. We all know how blessed was that word "Mesopotamia," and really the term "induction" seems as blessed to the minds of those who must find something wrong about electricity. A man altogether "kilt" by a wire connected to no dynamo, and, so far as history tells, not in contact with any wire carrying a current, is killed by "induction," whatever that may mean. Well, that is another lesson the electrical engineer has to learn. No matter his care, no matter the safety of his circuits, if a tale of damage can be laid to his work it will so be laid, and he must learn to "live it down." Putting aside joking, we once more insist that, while brilliant reputations may be made by sedulously prosing about the science of electricity, business success will only be obtained by as sedulous a care about what are generally termed minor details. The salient features of electric lighting are well known, and the humblest member of the profession cannot go far wrong, but the inattention to minor quantities and the failure to provide for troubles arising from outside causes are calculated to ruin the man who neglects them.

ON THE HEATING OF CONDUCTORS BY ELECTRIC CURRENTS.—III.

BY A. E. KENNELLY.

ON THE HEATING OF BARE COPPER WIRES AND STRIPS SUSPENDED IN AIR WITHIN DOORS.

It has been shown by Prof. Forbes and others that for bare cylindrical wires suspended in air, the temperature elevation produced in them by a current will be proportional directly to the square of the current and inversely to the cube of the diameter, provided that the loss of energy per unit surface of wire per second, known as the emissivity, be itself directly proportional to the temperature elevation. This assumption, though frequently made, is recognised to be untrue, and consequently this law cannot apply rigorously to suspended bare wires, just as it has been shown to be only approximately true for empanelled wires. Experiment shows that the emissivity rises rapidly with the rise of temperature, being in some cases nearly twice as great per degree C. at 100 deg. as it is at 20 deg. C. of temperature elevation.

Hitherto in calculating the limiting temperature of a bare wire suspended in air the emissivity has been generally taken from the data supplied by the careful experiments of Messrs. McFarlane and Nichols, who observed the rate of cooling of large metal spheres in special enclosures, conditions which are not fairly applicable to the cooling of wires, and which cannot, as Prof. Forbes himself pointed out, be strictly depended upon for that purpose.

He suggested that the effect of convection was not re-

portional to the surface, while radiation was; and experiments have verified this belief. Thus the emissivity for a polished copper surface, in the experiments of McFarlane and Nichols, was about 0.000168 therm per degree C. between 0deg. and 60deg. C. With this value Forbes and others have been led to greatly underestimate the carrying capacity of bare suspended wires. In the table accompanying his paper already mentioned, the calculated currents to raise the temperature of bright copper wires of 0.040in. and 0.120in. diameter 49deg. C. are 6.5 and 33.5 amperes, respectively; while experiment shows that about twice as much current is needed in each case. In fact, the emissivity per degree C. has been found to vary from 0.00019 therm with a thin flat bright copper strip to 0.001364 therm with a bright copper wire 0.0356in. (0.0904 centimetre) diameter, at about 50deg. C. temperature elevation, or in the latter case some eight times as great an emissivity as that quoted from the previous data.

A hot wire suspended in air parts with its heat both by convection and radiation. These two processes are essentially distinct, and are governed by different laws, so that the complete treatment of the subject can only be attained by dealing with each separately, and summing their effects.

was found that a comparatively small disturbance of the air exercised a decided cooling influence on the wire. Thus a fan gently waved beneath and at right angles to one of these 25ft. lengths of wire under test produced a diminution in its resistance that was plainly discernible, and arrangements were therefore made to keep the air as free from disturbance as possible. For the same reason all the observations, though they reached their practical maxima much more quickly than had been the case with the panelled wires, were more variable and never remained quite steady. The readings had consequently to be repeated several times and means taken to obtain fair results.

The emissivity of the strip (in its upright position, to be later described) proved to be 0.24 watt per linear centimetre, at 50deg. C. temperature elevation, its surface per centimetre being 5.11 sq. cms., while the emissivity of the smallest wire was 0.08 watts per linear centimetre at the same temperature elevation, its surface per centimetre being 0.284 sq. cm. Both these measurements being referred to the unit surface instead of unit length, give, respectively, 0.047 and 0.28 watts per sq. cm., thus making the emissivity of the small wire about six times as great as that of the strip for the same temperature elevation. From this great discrepancy it appeared probable

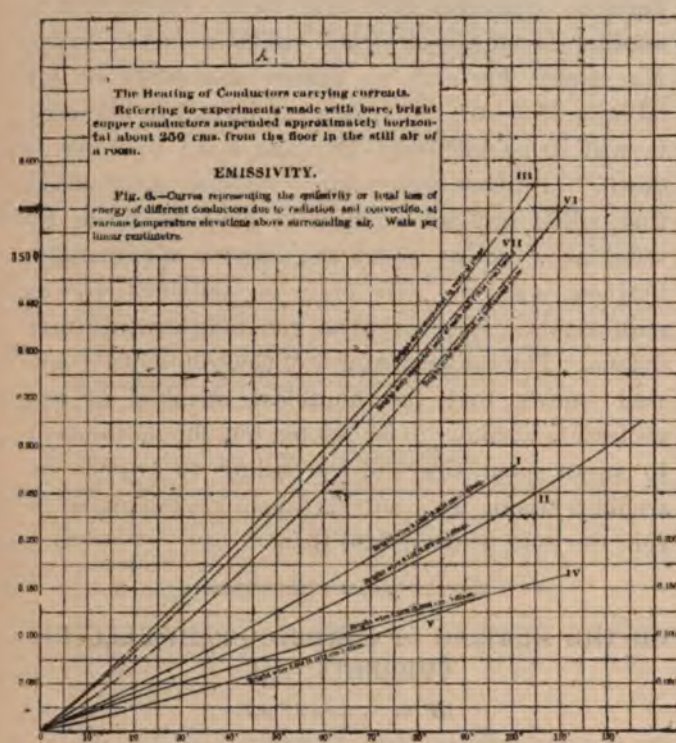


FIG. 6.—A.

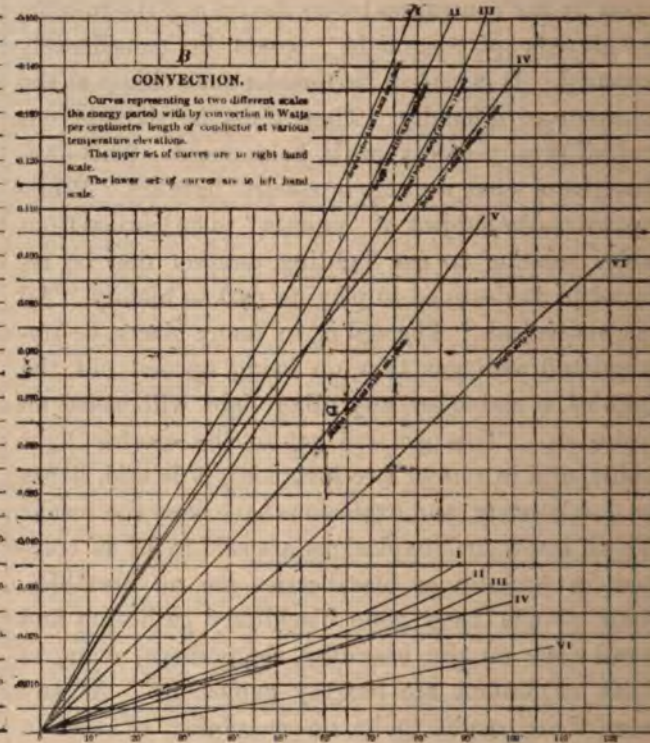


FIG. 6.—B.

The experiments to be described have succeeded in determining up to temperature elevations of 100deg. C. the separate rates of convection and radiation, together with the conditions to which they are independently subject. It is true that to determine all these conditions accurately would demand much further investigation, but the results appear to be at least reliable as a good first approximation.

Instead of dealing with the emissivity in therms, as has been customary, it will be more simple and direct to give all the results in watts.

Fig. 6 represents the temperature elevation measured with different current strengths passing through uninsulated copper conductors suspended in air within doors. Five different conductors were tested, and of these four were copper wires of diameters from 0.0356in. (0.0904 cm.) to 0.1345in. (0.341 cm.). The fifth was a strip of bright brush copper, lin. (2.54 cms.) wide and 0.0065in. (0.0165 cm.) thick. Curves I, II, III, IV, V, VI, and VII are the traces of the observations made upon them. Their surfaces were all brightened with fine emery paper, except that of the strip, which needed no polishing. The wires were suspended about 8ft. (250 cms.) above the floor, between opposite walls of the laboratory, in the still air with the windows closed. These precautions were taken because it

that the convection, instead of being proportional to the surface, like radiation, was equal in both cases, or nearly so; for if the convection had been proportional to the surface the mere difference in the form of the two conductors, whose surfaces were of similar appearance, could hardly account for so large a discrepancy. By assuming the convection to be equal for both wire and strip a pair of simultaneous equations was supplied by each pair of corresponding elevation points in the observation curves, thus giving radiation and convection independently for each such pair. The results for the radiation obtained in this way are:

Radiation for both wire and strip:

				Watts per sq. cm.
At	10 degrees C.	temperature elevation	.....	0.004765
"	20	"	"	0.01057
"	30	"	"	0.01720
"	40	"	"	0.02466
"	50	"	"	0.03312
"	60	"	"	0.04103
"	70	"	"	0.04995
"	80	"	"	0.05927
"	90	"	"	0.06796
"	100	"	"	0.07790

a rate of increase considerably beyond arithmetical pro-

gression. The test of the accuracy of the assumption on which these figures are obtained must be the accordance of this series with the laws of radiation as they are independently known.

MM. Dulong and Petit have published in the seventh volume of the *Annales de Chimie et de Physique*, 1817, a veritable poem in physical investigation upon the laws of cooling bodies. In their experiments the radiation was found to vary with the temperature elevation in geometrical progression expressed by the equation :

$$h = c (1.0077)^{\theta} \left\{ (1.0077)^t - 1 \right\};$$

where h is the quantity of heat lost by radiation from a hot body per square centimetre per second; c , a constant depending on the nature of the radiating surfaces; θ , the temperature of surrounding bodies, and t the temperature elevation of the hot body in degrees C.

Taking this formula as representing the best existing knowledge of the rate of radiation with temperature, the test of the above assumption is in the accordance of the above series of calculated radiations with a similar series obtained from Dulong and Petit's equation, making t successively 10, 20, 30, etc., up to 100. The numbers so arrived at are :

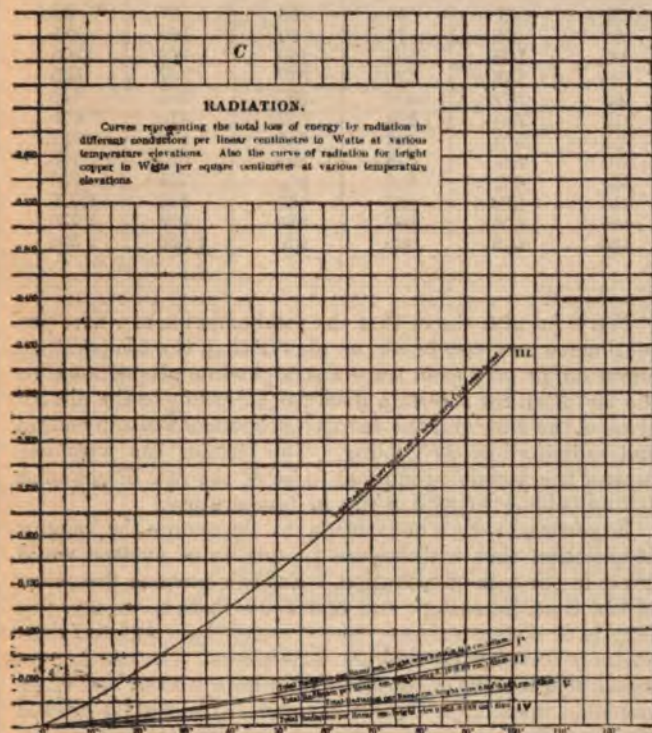


FIG. 6.—C.

$1.0077^{10} - 1 = 0.0797$	$1.0077^{60} - 1 = 0.5844$
$1.0077^{20} - 1 = 0.1658$	$1.0077^{70} - 1 = 0.7108$
$1.0077^{30} - 1 = 0.2587$	$1.0077^{80} - 1 = 0.8471$
$1.0077^{40} - 1 = 0.3591$	$1.0077^{90} - 1 = 0.9944$
$1.0077^{50} - 1 = 0.4675$	$1.0077^{100} - 1 = 1.1534$

TABLE A.

Temp. elevation.	Dulong and Petit's series.	Factor of comparison.	Dulong and Petit's series referred to 40deg. C. elevation.	Calculated series from wire and strip.	Discrepancy.
deg.					
10	0.0797	0.06866	0.05473	0.04765	-0.0007
20	0.1658	—	0.01138	0.01057	-0.0008
30	0.2587	—	0.01776	0.01720	-0.0006
40	0.3591	—	0.02466	0.02466	Standard.
50	0.4675	—	0.03210	0.03212	+0.00002 min.
60	0.5844	—	0.04013	0.04103	+0.0009
70	0.7108	—	0.04881	0.04995	+0.0011
80	0.8471	—	0.05817	0.05927	+0.0011
90	0.9944	—	0.06827	0.06796	-0.0003
100	1.1534	—	0.07919	0.07790	-0.0013 max.

To test the degree of accordance between the two series, the fourth element, corresponding to 40 deg. C. (that being

probably the most favourably situated for accuracy in observation), may be multiplied by 0.06866 to make it coincide with the calculated radiation 0.02466, and all the terms of the latter series may be similarly multiplied by the same factor. We then obtain the results given in the previous table A.

This agreement must be considered very satisfactory, and it is difficult to suppose it merely coincidental. It not only strengthens the reliance to be placed on Dulong and Petit's law, but it also amounts to a demonstration that the convection does not depend upon the surface, or that at least it can only do so in a very limited degree.

The radiation in watts per square centimetre from a surface of bright copper may therefore be accepted as 0.0687 $(1.0077^t - 1)$ under the condition of these experiments. But Dulong and Petit's law requires that this factor 0.0687 should itself be a function of the temperature of surrounding bodies, or in other words that the radiation loss from a hot wire for a given temperature elevation increases with the absolute temperature. It may therefore be assumed that

$$0.06866 = c (1.0077)^{\theta};$$

and in these experiments, θ , the temperature of the surrounding air, was about 26deg. C., so that

$$c = \frac{0.06866}{(1.0077)^{26}} \\ = 0.05625.$$

Whence the complete expression for the radiation from a bright copper wire in watts per square centimetre is

$$0.05625 (1.0077)^{\theta} [(1.0077)^t - 1].$$

It is to be observed, however, that this factor $(1.0077)^{\theta}$ is a deduction only, as yet not verified by experiment. It is difficult to decide this point in the summer season, but it is hoped to determine the question of its existence experimentally during the ensuing winter by observing whether the radiation does vary to such a degree for given temperature elevations when the temperature of surrounding bodies is changed. Should this factor's existence be verified it would completely establish the application of Dulong and Petit's law. If, on the other hand, the variation is not to be detected, while it would certainly weaken the position, the general evidence, apart from Dulong and Petit's law, is sufficient to maintain the use of the term $[(1.0077)^t - 1]$ while the factor 0.06866 would necessarily be regarded as independent of θ . With this reservation the retention of the factor is probably justified, especially as for most practical purposes the question is not a vital one.

The following table gives the radiation in watts per square centimetre of bright copper for $\theta = 25$ deg. C., and if the factor $(1.0077)^{\theta}$ be found to have an experimental existence it will be a simple matter to amplify the table for various values of θ from zero to 30deg. C.

Radiation Table in Watts per Square Centimetre for Bright Copper.

Temperature elevation.	$(1.0077^t - 1)$	Radiation.
Deg. C.		
5	0.0391	0.002665
10	0.0797	0.00543
15	0.1219	0.00831
20	0.1658	0.0113
25	0.2114	0.0144
30	0.2587	0.0176
35	0.3080	0.0210
40	0.3591	0.0245
45	0.4123	0.0281
50	0.4675	0.0319
55	0.5249	0.0358
60	0.5844	0.0398
65	0.6464	0.0441
70	0.7108	0.0484
75	0.7777	0.0530
80	0.8471	0.0577
85	0.9194	0.0627
90	0.9944	0.0678
95	1.0724	0.0731
100	1.1534	0.0786

The radiation is thus roughly 0.0006 watt or 0.00014 therm per square centimetre per degree C., increasing in geometrical ratio, and one square metre of bright copper at 100deg. C. elevation would radiate about 800 watts.

The same series of simultaneous equations which gave the radiation values furnish also the convection for wire

TABLE OF CURRENT STRENGTHS CAPABLE OF ELEVATING THE TEMPERATURE OF BARE COPPER WIRES OF 98 PER CENT. CONDUCTIVITY SUSPENDED IN STILL AIR.

Diameter of conductor.		5deg. C.		10deg. C.		20deg. C.		40deg. C.		80deg. C.	
Inches.	Cms.	Bright.	Blackened.	Bright.	Blackened.	Bright.	Blackened.	Bright.	Blackened.	Bright.	Blackened.
0.05	—	7	8	12	13	15	16	22	23	28	31
0.10	—	17	18	24	26	33	36	50	52	62	70
0.15	—	27	30	38	43	53	60	74	84	100	114
0.20	—	49	41	52	62	74	85	103	120	140	166
0.25	—	38	55	67	81	96	114	135	161	185	224
0.30	—	61	71	85	100	120	143	168	204	233	285
0.35	—	73	87	102	124	145	176	204	249	282	350
0.40	—	87	106	122	148	172	211	241	297	335	418
0.45	—	101	124	142	173	198	248	280	348	392	492
0.50	—	116	144	162	200	228	285	320	402	449	570
0.55	—	131	162	184	228	260	325	362	460	510	650
0.60	—	146	182	206	258	290	366	407	518	571	731
0.65	—	162	203	229	288	322	408	452	578	636	820
0.70	—	178	226	252	320	355	454	500	640	704	908
0.75	—	196	249	276	352	386	498	550	704	772	1,000
0.80	—	213	273	300	386	420	544	598	768	819	1,100
0.85	—	232	300	324	420	456	591	648	838	908	1,190
0.90	—	250	324	348	455	490	640	700	908	980	1,290
0.95	—	270	352	375	492	530	692	752	982	1,060	1,420
1.00	—	290	375	400	528	565	740	800	1,050	1,130	1,500
—	0.20	12	13	18	20	25	27	35	38	47	53
—	0.40	28	30	40	46	56	64	77	90	105	121
—	0.60	45	50	63	75	90	105	125	150	172	206
—	0.80	64	76	90	108	126	152	179	217	247	305
—	1.00	85	104	120	147	169	207	236	290	329	410
—	1.20	108	133	150	184	212	264	298	372	416	526
—	1.40	132	163	184	230	261	328	364	461	512	652
—	1.60	156	190	220	276	310	392	415	553	610	785
—	1.80	180	230	256	326	360	462	510	650	715	924
—	2.00	201	267	293	377	413	532	583	750	819	1,070
—	2.20	237	308	330	430	465	605	662	858	928	1,220
—	2.40	268	348	372	486	524	685	746	970	1,050	1,380

and strip and its rate of change. Fig. 6 gives the result of the analysis. Curves Nos. I., II., IV., and V., in the left-hand section, A, represent the total emission in watts per linear centimetre as actually measured, and as composed of both radiation and convection. In the right-hand section, C, the total radiation obtained in the above manner is represented in the corresponding curves I., II., IV., and V., drawn to the same scale. The difference at each pair of corresponding points between the total emission and the total radiation represents the convection loss, and this is given by the lower set of curves, I., II., IV., and V., in the central section, B, to the same scale, and also in the upper curves to this scale magnified five times for the benefit of clearer comparison. It will be observed that the convection was nearly the same in each case, the effect of increasing the diameter of the wire from 0.0356 in. (0.0904 centimetre) to 0.1345 in. (0.3476 centimetre)—that is, nearly four times—only appearing to increase the convection 20 per cent., thus corroborating the results arrived at by the test of agreement with Dulong and Petit's law. The convection appears to increase rather more rapidly than the temperature elevation, except in the case of the smallest wire. This result is not in accordance with those of Dulong and Petit, who found the convection, in their experiments, with cooling spheres to increase as the power 1.233 of the temperature elevation; or, according to the factor, $t^{1.233}$. It is quite possible, however, that the convection for spheres may not be the counterpart of that for long wires, and it is to be observed that not only are the laws of convection a branch of hydrodynamics more complex than those of radiation, which does not appear to vary with the form of surface, but the number and precision of these particular experiments scarcely warrant any more definite deductions to be made in this direction. For practical purposes, therefore, it will be sufficient to take a mean value of the convection and assume it to be proportional to the temperature elevation until further investigation may afford more precise information. We may, therefore, take the loss of heat by convection from any wire at the mean value of 0.00175 watt per linear centimetre in still air for each degree C. of temperature elevation—that is, one kilowatt for every 114 metres at 50deg. C. temperature rise.

Fig. 6 (a) also shows that the total emission of a wire per centimetre may rise faster or slower than the temperature elevation, or may even trace a straight line proportional to the elevation for a certain distance, according to the dimensions of the wire and the relative proportions of convection and radiation in its cooling. The smaller the wire the greater the likelihood appears to be of the rate of emission falling behind the rate of rise in temperature.

Experiments were next made to determine the amount of variation that a difference in quality of surface could effect in the rate of radiation. For this purpose five wires of the same dimensions and material—that is to say, five lengths of the same wire—were suspended parallel and their surfaces coated with different substances. On another occasion five lengths of the same strip were treated and experimented upon in a similar manner. The results showed that in still air a black coating of sulphide of copper, produced by painting the bright surface with a solution of sulphide of sodium, reduced the temperature elevation corresponding to any given current nearly 30 per cent. both for wires and strips; while a coating of lampblack and shellac (dead black carpenter's varnish) similarly reduced the temperature of the strips nearly 50 per cent. This has a useful bearing upon bare copper conductors within doors, say in an illuminating central station, for if their surfaces are so large that the heat loss takes place principally by radiation (and for surfaces above five square centimetres per linear centimetre convection plays but a small part), the saving of energy produced by painting the conductors with this varnish will, through the lowered tem-

perature and resistance, amount to $\frac{t}{6}$ per cent., where t is

the previous temperature elevation. So that if these conductors be maintained at 50deg. C. elevation in the bright state this will fall to about 27deg. C. after painting, with a resultant saving of about 8 per cent. of the whole energy previously generated by the current in the painted length. This applies not only to bright copper, but also to copper that has become slightly tarnished by age, but may not apply equally to copper whose surface is encrusted with dust or smoke.

By first determining the radiation and convection for the

bright wire and strip, then assuming the convection to be equal for the other coated wires and strips, respectively, the mean ratio of the radiation from each quality of surface to the radiation of bright copper was calculated to be as follows:

For the wires: Thin coating of brown shellac varnish, 1·6; thick coating of copper sulphide (CuS), 2·3; thick coating of lampblack made adherent by molasses, 2·0.

For the strips: Thick coating of brown shellac varnish, 1·8; rather imperfect and thin coating of copper sulphide, 1·5; lampblack by deposit from smoky candle, 1·4; thin coating of varnish, lampblack and shellac, 2·0.

The coating of copper sulphide was not so successful in promoting radiation with the strips as with the wires, partly owing, however, to imperfect coating. The necessity for a compact adherent layer in obtaining active radiation is also shown, for while lampblack, deposited from a flame, only added 42 per cent. to bright radiation, lampblack applied with thin shellac varnish doubled it.

We may, therefore, take the radiation from a properly blackened wire as double that from a bright wire.

Experiments were also made with two strips of bright copper to ascertain how far their convection was affected

upright strip was greater than that obtained from it in the previous test while unsupported and drooping, and the emission from the flat strip less—a result quite in accordance with expectation.

Fig. 6 (B) gives the calculated values of the convection from the upright and flat strip. The latter is seen to be about 45 per cent. less than the former, a rather surprising difference, for it would indicate that, supposing the upper surface of the flat strip to be equally affected by convection to the same degree as one side of the upright strip, the convection from the lower surface would then be ten times less.

The final results of the experiments on bare wires in still air point to the following means of calculating the current strength necessary to raise any given copper wire to a certain temperature elevation:

- Let d be its diameter in centimetres;
 t „ the given temperature elevation;
 r „ its resistivity at 0deg. C., in ohms;
 θ „ the temperature of surrounding objects;
 m „ the coefficient of surface for radiation.
 Let $t + \theta = T$, the temperature attained by the wire.

FIG. 7.—Curves representing the current strengths required to elevate the temperature of wires of diameters up to lin. 5, 10, 20, 40, and 84° C.; for bright and blackened copper of 98 per cent. conductivity in still air at 20° C.
 Ordinates: Current strength amperes.
 Abscissas: Diameter in inches and cms.
 Broken lines refer to bright copper.
 Full lines refer to blackened copper.

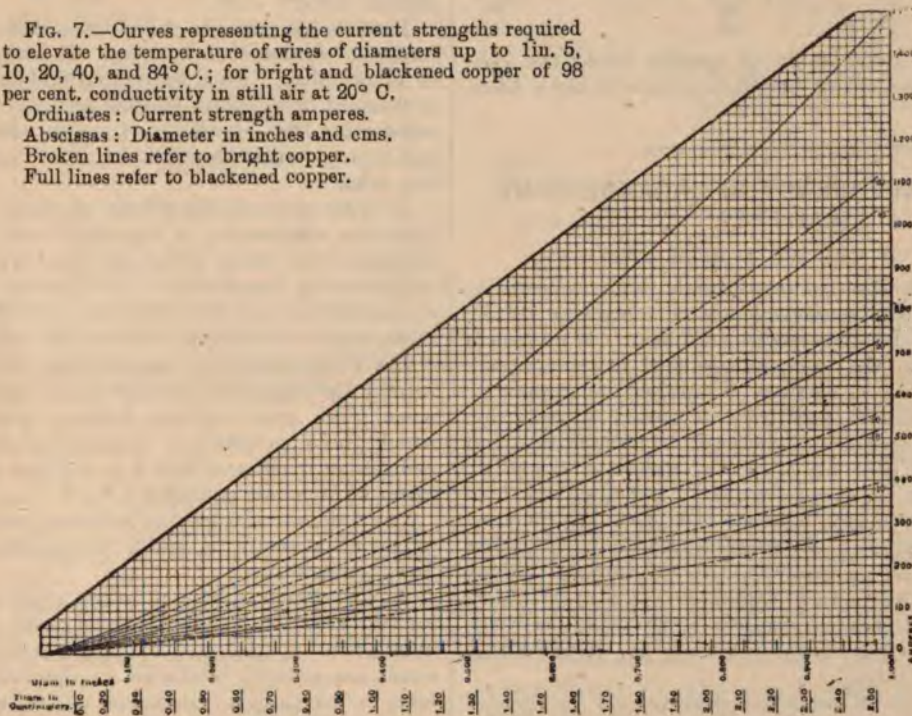


FIG. 7.—Curves Representing the Currents Required to Heat Wires to Different Temperatures.

by their plane of suspension. In the above-mentioned tests of strips they were all secured at their extremities to lie flat; but toward their centre they each dipped to one side or the other out of the horizontal plane, making a dip of about 45deg., and the following tests were made to determine whether the convection depended to any extent upon this angle:

These two strips were supported in air at about every three feet, one of them being fixed in the vertical plane, while the other rested flat above all the supports. Their perpendicular distance apart was eight inches (21 centimetres). The testing current was sent through them in series and the temperature elevations determined for each in the usual way. Curves III. and VI., Fig. 6 (a), represent their relative behaviour. In the first trial the temperature elevation of the flat strip reached 120deg. C., at 101 amperes, while that of the upright was only 102·5deg. C. To make certain that this difference was not due to any inequality of radiating power, the strips were exchanged in position, the upright one being now flat, and *vice versa*. On repeating the test, the temperature elevation of the flat strip reached 130deg. C. at 100 amperes, while that of the upright strip was 101·3deg. C., practically the same result, and the only means of accounting for the difference was the plane of the strips. The diagram shows that the emission of the

Then its resistance per centimetre will be:

$$\frac{4 r (1 + 0.00388 T)}{\pi d^2} \text{ ohms.}$$

The energy developed per centimetre by a current of c amperes will be:

$$\frac{4 c^2 r (1 + 0.00388 T)}{\pi d^2} \text{ watts per centimetre.}$$

The heat convected from it will be: $0.00175 t$ watts per centimetre.

The heat radiated from it will be:

$$d m \pi \times 0.0687 \left[(1.0077)^t - 1 \right] \text{ watts per centimetre.}$$

Or if the radiation for t deg. elevation be taken from the previous table and denoted by R_t :

The total radiation per linear centimetre = $d m \pi R_t$ watts.
 Equating the gain and losses,

$$\frac{4 c^2 r (1 + 0.00388 T)}{\pi d^2} = 0.00175 t + d m \pi R_t;$$

$$\text{whence, } c = 0.886 d \sqrt{\frac{d m \pi R_t + 0.00175 t}{r (1 + 0.00388 T)}}$$

for copper of 98 per cent. conductivity $r = 1.65 \times 10^{-6}$; so that simplifying—

For bright wires :

$$m = 1, c = 28.9 d \sqrt{\frac{570 Q R_0 + t}{1 + 0.00388 T}};$$

for blackened wires :

$$m = 2, c = 28.9 d \sqrt{\frac{1140 Q R_0 + t}{1 + 0.00388 T}};$$

where $Q = \pi d$, the circumference of the wire.

The following table of current strengths capable of elevating the temperature of bare copper wires of 98 per cent. conductivity suspended in still air, 5deg., 10deg., 20deg., 40deg., and 80deg., above surrounding air and objects at 20deg. C., has been calculated for bright and blackened wires by the use of these formulæ. It will be observed that the currents are given up to 1,500 amperes, while 100 amperes was the experimental limit to which this series was carried. To present, however, a comparison of the results calculated in the table with those actually measured up to that limit the following may be noticed :

For elevation of

5 deg. C., the observed current was	24	amperes ; tabulated,	24
10deg. C.,	"	34.5	"
20deg. C.,	"	47.5	"
40deg. C.,	"	67	"
80deg. C.,	"	92	"

Fig. 7 gives the above table in graphic form, the continuous lines representing bright, and the broken lines, blackened, wires.

FORM AND EFFICIENCY OF INCANDESCENT FILAMENTS.*

BY CHARLES J. REED.

If we pass an electric current through any conductor, as a cylindrical wire, its temperature tends to increase by the transformation of electrical energy into heat. If no heat is allowed to escape, the temperature will increase indefinitely, or until the conductor is melted or otherwise destroyed. If the heat is allowed to escape by radiation alone from the surface of the conductor, its temperature will increase only until the rate of loss by radiation is exactly equal to the rate of transformation. By heat we here include all radiant energy, whether of high or low degree.

As the temperature of an incandescent body increases, not only does the actual quantity of radiant energy increase, but its wave lengths diminish. Hence, as experience has shown, after incandescence is reached, increasing the temperature in a given ratio increases the light emitted in a much greater ratio.

The exact relation between temperature and luminosity is not known, and it is probably not very simple, if such a relation exists at all. The phenomenon of luminosity is really a physiological one and depends partly upon individual optical capacity ; some persons being able to see above and some below the visible spectrum of the average human eye. The radiant energy we call light is one thing. The sensation of luminosity by which we always estimate light is an entirely different thing. A constant source of light may vary greatly in luminosity, according to the condition of the respective mechanism and its individuality.

But even ignoring the physiological aspect of the question, the nearest approach we have to formulæ for radiation are the approximate empirical formulæ of Dulong and Petit and of Stefan ; which are for total radiations of a low temperature and limited range. They cannot apply to light alone, nor even to total radiation of high degree.

It is unfortunate that there exists no instrument more reliable than the retina of the living eye for measuring the intensity of radiant luminiferous energy, and no method of reading the measurements more accurately than individual guesses. We can measure radiant thermal energy of low degree with Langley's bolometer ; we can measure radiant actinic energy by the chemical action it produces ; and we can measure total radiant energy in a variety of ways ; but how can we isolate or measure radiant luminiferous energy ? If there were a high temperature

thermometer or other instrument for accurately measuring high temperature, we might attack this problem with some hope of results.

It is sufficient, however, for our present purpose to know what the eye is able to tell us—namely, that increasing the temperature increases the light in a greater ratio. From this it follows that the efficiency of an incandescent filament is some direct function of its temperature above that of the surrounding space.

Granting that the efficiency increases with increased temperature, we have now to determine whether the efficiency does or does not depend on any other conditions. It has frequently been claimed that the efficiency depends upon the form of the filament, whether it be cylindrical, flat or square. At a meeting of this institute of June 8, 1886, for instance, this was by general consent considered an established fact. Others have asserted, but without giving any proof, that the efficiency depends upon the pressure, some claiming that low-tension series lamps and others that high-tension multiple lamps are the more efficient. Others, again, have claimed that at the same pressure and with the same shaped filament, lamps of greater candle-power have a different efficiency from lamps of smaller power.

The trouble seems to have been that we are not always careful to distinguish between efficiency and convenience or adaptability. Each individual finds that a certain form of filament or a certain method of distributing gives better satisfaction than another, or is more suited to his purpose, and soon persuades himself that it is "more efficient" than any other.

In order to study the effects of these various conditions upon the efficiency of a filament, it will be convenient to eliminate the effects which we know will be produced by variations in temperature. We assume, therefore, in this discussion that all the filaments, and all parts of the filaments under consideration are at the same temperature.

Let T represent this temperature, and T' the temperature of the supposed vacuum space surrounding the filament. We must assume, further, that the material of which the filaments are constructed is perfectly homogeneous in itself, and that it is uniform in all the various forms of filaments considered.

Let S denote the specific radiating power of the material at the temperature, T , and S' , its specific resistance at the same temperature.

Any variation in S or S' might affect the efficiency, and for this very reason experimental proof is very difficult to obtain. Comparisons of filaments made by different processes are entirely worthless in determining the effect of form or length of a filament on its efficiency.

It is a difficult matter to produce by the same process two carbons of different sizes and shapes that shall have the same specific radiating power and specific resistance at the same temperature. And to produce them by different processes is entirely out of the question. Any comparison, therefore, of short series filaments with long multiple filaments of a different manufacture is of no value whatever in settling this question.

Let C represent the candle-power of any filament at temperature, T .

c , its current.

E , the potential difference at its terminals.

R , its resistance.

r , its radius (considered as a cylinder).

L , its length.

H , the energy received per unit of time.

H' , the energy radiated per unit of time.

Since the energy developed in any portion of an electric circuit is proportional to the current and pressure, we have

$$H = K E c, \quad \dots \quad (1)$$

in which K is a constant depending upon the units employed.

If we neglect the small quantity of heat lost by conduction from the ends of the filament to the conducting wires, and assume that the space surrounding the filament is a perfect vacuum, then the entire energy of the current will be expended in radiation and we have

$$H = H'. \quad \dots \quad (2)$$

* Read before the American Institute of Electrical Engineers, New York, November 19, 1889.

Let K' represent a constant depending on $T-T'$.

The rate of radiation of any surface depends only upon the elevation of its temperature above that of the surrounding space and the specific radiating power of the surface at that temperature. We have therefore,—

$$H = H' = K' S \times 2 \pi r L = K E c \quad (3)$$

The resistance of any conductor is proportional to its length and inversely proportional to its cross-section, and we have—

$$R = S' \frac{L}{\pi r^2} \quad (4)$$

From Ohm's law and (4)

$$c = \frac{E}{R} = \frac{E \pi r^2}{S' L} \quad (5)$$

By eliminating successively E , c , and r from (3) and (5) we get

$$\frac{K' S \times 2 \pi r L}{K E} = \frac{c S' L}{\pi r^2}, \text{ or } \frac{c^2}{r^3} = \frac{2 \pi^2 K' S}{K S'} \quad (6)$$

$$\frac{K' S \times 2 \pi r L}{K E} = \frac{E \pi r^2}{S' L}, \text{ or } E^2 r = \frac{2 K' S L^2 S}{K} \quad (7)$$

and
$$\frac{K E c}{K' S \times 2 \pi L} = \sqrt{\frac{c S' L}{\pi E}} \quad (8)$$

From (6) $K' S \times 2 \pi^2 r^3 = K S' c^2$. Hence,

$$r = \sqrt[3]{\frac{K S' c^2}{2 K' S \pi^2}} \quad (9)$$

and
$$C = \pi \sqrt{\frac{2 K' S r^3}{K S'}} \quad (10)$$

showing that the square of the current is proportional to the cube of the radius or diameter of the filament for all lamps at constant temperature; and that this relation is independent of the pressure, of the length and resistance of the filament, and independent of the candle-power.

From (7)

$$K' S \times 2 L^2 S' = K E^2 r. \text{ Hence,}$$

$$L = \sqrt{\frac{K E^2 r}{2 K' S S'}} = E \sqrt{r} \sqrt{\frac{K}{2 K' S S'}} \quad (11)$$

and
$$r = \frac{L^2}{E^2} \times \frac{2 K' S S'}{K} \quad (12)$$

showing that the ratio of the square of the length to the diameter depends only upon the pressure, and is independent of candle-power and resistance.

From (8)

$$K^2 E^3 c = 4 \pi K^2 S^2 S' L^3. \text{ Hence,}$$

$$E = \sqrt[3]{\frac{L^3}{c} \sqrt{4 \pi K^2 S^2 S'}} \quad (13)$$

and
$$c = \left(\frac{L}{E}\right)^3 \times \frac{4 \pi K^2 S^2 S'}{K^2} \quad (14)$$

showing that the current is proportional to the cube of the ratio of the length to the pressure.

Since K' , S , and S' are constant, both the light and the heat radiated will be proportional to the surface, and we have

$$C = K'' L \times 2 \pi r \quad (15)$$

in which K'' is a constant depending upon the units employed, and upon T ,

Hence,
$$L = \frac{C}{2 \pi K'' r} \quad (16)$$

and
$$r = \frac{C}{2 \pi K'' L} \quad (17)$$

EFFICIENCY CONSTANT.

Combining (15) with (3)

$$\frac{K' S C}{K''} = K E c, \text{ or } \frac{C}{K E c} = \frac{K''}{K' S} \quad (18)$$

which shows that the candle-power is proportional to the energy, $K E c$; or that the efficiency, $\frac{C}{K E c}$, is constant

and independent of the pressure, length, radius and resistance, current and candle-power of the filament. This means that the energy required to produce a given candle-power will be proportional to the candle-power and will be the same, whether it is expended in driving a large current through a short, thick filament, or a small current through a long, slender filament; provided the temperature or state of incandescence is the same, and provided no heat is lost by conduction through the terminal wires.

Equation (18) shows also that the efficiency does depend upon K' , K'' , and S —that is, upon the temperature of the filament, the temperature of the surrounding space and the specific radiating power, and upon them only.

From (18)

$$C = E c \times \frac{K K''}{K' S} \quad (19)$$

$$E = \frac{C}{c} \times \frac{K' S}{K K''} \quad (20)$$

and
$$c = \frac{C}{E} \times \frac{K' S}{K K''} \quad (21)$$

From (4)

$$r = \sqrt{\frac{S' L}{\pi R}} = \sqrt{\frac{S'}{\pi}} \times \sqrt{\frac{L}{R}} \quad (22)$$

and
$$L = \frac{\pi r^2 R}{S'} \quad (23)$$

From (5) $E = R c \quad (24)$

From (21) and (24)

$$\sqrt{c} = \frac{C}{c R} \times \frac{K' S}{K K''} = \sqrt{\frac{C}{R}} \times \sqrt{\frac{K' S}{K K''}} \quad (25)$$

FORM OF CROSS-SECTION.

We have thus far confined ourselves to the consideration of cylindrical filaments varying in length and diameter. It remains now to show that the efficiency is independent of the form of cross-section.

Let us suppose we have a number of lamps, all made of the same material, having the same specific resistance and radiating power, all burning at the same temperature, and all giving the same amount of light. Let them be of any pressure, and let the cross-section be of any form, circular, elliptical, square, triangular, etc. The filaments will all have equal radiating surfaces, since unequal surfaces of the same character at the same temperature could not radiate equal amounts of light. But equal services of the same character at the same temperature must radiate equal amounts of heat of all wave lengths. Hence, the total amounts of radiant energy are equal. Since the energy received is equal to the energy radiated, and the amounts of light are equal, we have

$$C = Q E c \quad (26)$$

in which Q is a constant; and from (18) we find its value to be

$$Q = \frac{K' K''}{K S} \quad (27)$$

This shows that the efficiency is independent of the form of cross-section of the filament, and depends only upon the temperature, the specific radiating power of its surface, and the temperature of the surrounding space.

When we find, therefore, that one lamp is more efficient than another we must infer, not that it is on account of larger or smaller size, not because it is on a series or on a multiple circuit, not that it is because it has high or low resistance, or a certain form of cross-section, but that it is at a higher temperature, or is made of material having a different specific radiating power.

FORMS OF CROSS-SECTION.

Of all possible forms of cross-section, the circular has the largest area for the same radiating surface per unit of length, and, consequently, has the advantage of great strength. The current density will also be less in

this than any other form; and hence, any "disintegrating" or "electrolytic effect" of the current, if there is any such, will be least in the cylindrical filament. This will be made clear by supposing a number of lamps of equal candle-power to be burning at the same temperature and pressure, but having various forms of filament, cylindrical, flat, square, etc. We have already seen that these lamps all consume equal amounts of energy, and since they have the same pressure they must take the same current. Therefore, the filament which has the greatest area of cross-section will have the least current density. The fact that the cylindrical filament has the greatest cross-section does not signify that it will require a greater current to keep it at the same temperature. Its form is better adapted for retaining heat than any other. Again, the several lamps will have equal resistance; otherwise they could not take equal currents with the same pressure. From this it follows that the cylindrical filament will be longer and will have less surface and greater mass per unit of length than any other.

A tubular filament would have a greater external diameter, but smaller cross-section of material, and would be shorter than the cylindrical.

The advantages and disadvantages of the various forms may be summed up as follows.

The cylindrical has the advantage of greater strength and less current density on account of greater cross-section. It has the disadvantage of greater length and fragility.

The tubular filament is strongest in form, being shorter and of greater external diameter than the cylindrical. It has the disadvantage of greater current density than the cylindrical. Both the tubular and the cylindrical have the advantage of uniform illumination in all directions, except in and near the plane of the filament.

Flat, or angular, filaments have the disadvantage of great current density, and of being unequally heated, since the edges or projecting corners will always be a little cooler* than the other parts.

A short, thick filament has the advantage of being stronger and more durable than a long, slender one; but the disadvantage of wasting a great percentage of heat by conduction through the terminal wires. In this latter respect it is true that the long filament is slightly more efficient than the short. A 10-ampere filament a foot long would waste no more energy by conduction than a 10-ampere filament an inch long.

Aside from the difficulty of obtaining lamps of different types from different makers which have the same specific resistance and radiating power, there is the difficulty, or rather impossibility, of getting them all to burn at the same temperature, and the difficulty of knowing, even approximately, what that temperature is, and whether it is the same in two lamps or not. For these reasons no experimental comparisons yet published are of any value, either in corroborating or refuting these conclusions. There is one method, however, of testing the formulæ. This method the writer has tried upon some 25 different types with the most satisfactory results. The method is as follows:

A lamp is constructed with a filament of known dimensions, treated to the required process, and exhausted to a certain pressure, as determined by a McLeod vacuum gauge. It is then placed on a circuit of a certain pressure, which gives it a certain desired temperature or efficiency, and the candle-power and current are measured. From the data thus obtained, we calculate by the above equations all the data for lamps of other types. The lamps when made according to this data from the same material by the same process, and exhausted to the same pressure, should give the calculated candle-power at the calculated pressure.

(To be concluded.)

* It was asserted before this institute, June 8, 1886, that the edges or corners of a square filament are hotter than the remainder of the surface, but no reason was given. Such a statement scarcely needs refutation, being contrary, not only to established laws, but to the most commonplace and everyday experience. We need only observe the cooling of a square bar of red-hot iron to convince ourselves that the sharp corners are the coolest parts. And they would remain the coolest parts even if the heat were continually supplied by an electric current to the interior of the bar.

INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution on December 12, after the adoption of the report of the council and the passing of the usual votes of thanks, the discussion on Mr. Addenbrooke's paper, "Electrical Engineering in America," was resumed.

Mr. Lant Carpenter, who paid a hurried visit to America during August and September, said he quite concurred in Mr. Addenbrooke's remarks about the temporary character of the work, particularly in the western towns. In many places on the Pacific slope he found that water power was extensively used, both for arc lighting and for tramway work; one town in Washington, he observed, had laid down electric tramways before making the common roads. Incandescent lamps are comparatively rarely seen in the far West, and from enquiries he learned that where they had been tried, the stations were so badly managed that the life of the lamps averaged between 200 or 300 hours. Passing on to Canada, he said that Quebec, Montreal, and Ottawa were all lighted electrically by water power, and in the latter city he was informed that many alternate-current motors of the Tesla type were in constant use. Another fact that struck him was the large numbers of long-distance telephone wires in use in the States. He also noticed that many of the wires were now being put underground.

Mr. G. S. Ram said he could not agree with Mr. Addenbrooke on the glaring character of arc lamps fixed on poles, and added that the tower system had been almost abandoned in New York in favour of poles. He greatly preferred the blaze of light in that city to the comparative darkness of London. As regards the character of overhead work, he thought the account given in the paper was not overdrawn, and in support of this he exhibited a photograph of a building in Broadway, New York, in which hundreds of wires were unintentionally included. On careful examination of the photograph the insulation on some of the wires was seen to be hanging in shreds.

Mr. C. E. Spagnoletti thought the necessities for insulation were so different in England and America that the systems could not be compared on the same basis. To show the great variation of insulation resistances in this country, he said that on the South Wales branch of the Great Western Railway the insulation resistance of the telegraph lines varies from several megohms to a few thousand ohms according to the weather. He also mentioned the difficulties experienced by Mr. Edison when experimenting in London and at Ealing with his automatic chemical telegraph. The maximum rate he could attain here was 500 words per minute, whereas in America he could get 2,000.

Mr. Preece, speaking of insulation requirements in the two countries, said that in his opinion the differences arise from the facts that the prevailing winds here are warmed and moistened by passing over the Gulf Stream, whilst in America, the shores being washed by Polar currents, the winds are cold and dry. Referring to his own visits to America, the speaker said he always benefited considerably by being associated with the "go-aheadness" of American engineers, and he believed that on visiting this country American engineers derived similar advantages.

Mr. Crompton said the paper would bear a good deal of study, and there were some points upon which he desired further information. For example—the method of preventing vibration, mentioned on slip 6 of the paper, would, if effective, be of great importance; for one would have expected such an arrangement to increase, rather than diminish vibration. Judging from the remarks about regulating resistances, on slip 7, he would infer that in this respect American was behind European practice, for on this side of the water such resistances had been done away with. The fact of alternate-current machines not being usually run in parallel (as attested by Mr. Addenbrooke) tended to confirm his (Mr. Crompton's) statements made in his paper on "Central Station Lighting," read in April, 1888. As regards the boiler, described on slip 10 of the paper, he thought such a design would not be tolerated in this country, for the upper parts of the tubes were liable to get overheated and collapse. Speaking of tramway work, Mr. Crompton said American engineers had been greatly favoured by being allowed to erect overhead wires anywhere and anyhow, but he was afraid such facilities would never be granted in England.

Mr. A. Reckenzaun deprecated the wholesale condemnation of posts made by Mr. Addenbrooke, and said that many were not unsightly, whilst some were ornamental. He considered the paper chiefly a criticism of the bad work done in America, and the good work was barely mentioned. For example, little is said of installations in which secondary batteries are employed, although there are many in constant operation, and electric railways are not described.

Mr. F. Reckenzaun concurred in his brother's remarks about the unfair criticism contained in the paper, and thought the differences of opinion arose from the totally different ideas as to the way in which electrical engineering should be carried out. In the American methods, he said, great skill and ingenuity was shown in combining economy with simplicity and efficiency. Although the arc lamps are not ornamental, yet they are simple and efficient, and cheap construction admits of them being universally used. He agreed in general with Mr. Lant Carpenter's remarks on incandescent lighting, but was inclined to believe its limited use was due to the people wanting the biggest and best light obtainable at the price.

Mr. Addenbrooke, in reply to the Messrs. Reckenzaun, said he had specially mentioned in his paper that the Thomson-Houston Company were putting up work much better than the average, and, as to posts, he was glad to say the tramway companies were making considerable improvements. The arrangement of flooring referred to by Mr. Crompton was not intended to diminish vibration, but to prevent such vibration being transmitted to the brickwork. As regards the boiler criticised by the same speaker, he (Mr. Addenbrooke) could

only say that those in charge of them informed him that it was intended to have more of them. It was not his intention to criticise all American electrical engineering in a hostile spirit, for he thought there was little difference in the capacity of English and American engineers. The necessities, however, of the two countries were entirely different, and each had to adapt himself to his own surroundings. The motors used on the arc circuits were, as far as he could learn, simply series ones, provided with switches for cutting out parts of the magnet coils. In concluding, Mr. Addenbrooke said he had the opportunity of conversing with many of the American engineers who visited this country in the summer, and all were greatly pleased with the kind and courteous manner in which they were received.

After the thanks of the meeting had been given to the author for his paper, **Dr. S. P. Thompson** directed attention to some American blue glass insulators, which he had brought for inspection, and remarked that in a recent American work on electric lighting, which was now being circulated in this country, these insulators are recommended as suitable for almost any purpose.

Mr. Addenbrooke also exhibited a piece of the cable used in underground work in New York; the chief point of interest being the hardness of the insulating material employed.

PHYSICAL SOCIETY.—Dec. 6.

Prof. REINOLD, F.R.S., President, in the chair.

Mr. J. W. Swan was elected a member of the society.

The following communications were read:

"On the Electrification of a Steam Jet," by **Shelford Bidwell, F.R.S.** The author showed that the opacity of steam issuing from a nozzle is greatly increased by bringing electrified points near it, and that its colour is changed to an orange-brown. Electrified balls and discs when placed in the steam produce similar effects, and when these are connected with an influence machine at work the decolouration of the jet rapidly responds to each spark. On examining the absorption spectrum of the unelectrified jet, little or no selective absorption was detected, but on electrification the violet disappeared, the blue and green were diminished, and the orange and red remained unchanged. From these results the author concludes that electrification causes an increase in the size of the water particles in the steam, from something small, compared with the wave length of light, to about $\frac{1}{1000}$ of an inch in diameter. Allied phenomena with water jets have been observed by Lord Rayleigh, who found that a straggling water jet is rendered much more coherent by bringing a rubbed stick of sealing-wax near it. These observations are of considerable meteorological interest, for the steam-jet phenomena go far towards explaining the cause of the intense darkness of thunderclouds, and of the lurid yellow light with which that darkness is frequently tempered. After making his experiments the author learnt that similar observation had recently been made by the late Robert Helmholtz, who viewed the steam jets by reflected light against a dark background. On electrification the jets became much better defined, and presented diffraction colours. Luminous flames also produced similar effects, and Mr. Bidwell has found that glowing touch paper is equally efficient. Helmholtz conjectures that the sudden condensation may be due to molecular tremors or shock imparted by the electrification upsetting the unstable equilibrium of the supersaturated vapour, just as a supersaturated saline solution is suddenly crystallised when disturbed. Another hypothesis suggests that condensation is caused by the introduction of solid matter into the jet by the exciting cause, thus providing nuclei upon which the vapour may condense. On reading Helmholtz's paper the author tried the effect of gas flames on water jets, and found that when luminous they influenced the jet considerably, whereas non-luminous flames had no appreciable effect. He also found that luminous flames are positively electrified, and demonstrated this before the meeting. **Prof. Rucker** thought the surface tension of the films surrounding the water jets would be modified by the presence of an electrified body, and that the smoke from the touch paper used in some of the experiments on steam jets would introduce solid particles and facilitate condensation. **Mr. Richardson** enquired whether a red-hot iron had any effect. **Dr. Fison** said he had made experiments on the electrification of flame, and found that potentials varying from +2 volts to $-1\frac{1}{2}$ volts could be obtained in the region within and surrounding a Bunsen flame. **Prof. S. P. Thompson** commented on the contrast between Mr. Bidwell's experiments and those of Dr. Lodge on the dissipation of fogs by electricity, and also asked whether the colour of the jet depended on the length of spark produced by the machine. **Prof. Forbes** thought a crucial test between the two hypotheses of Helmholtz could be obtained by trying the experiment in a germless globe. The **President** said he had recently noticed that gas flames were electrified. **Mr. Bidwell**, in replying, said he ought to have mentioned that the effect of flames on jets may be due to dirt, for if soap or milk be added to the water in the steam generator, no effect is produced by electrification or flame. As to change of colour with spark length, little (if any) variation is caused thereby. He had not tried whether a red-hot iron produced any effect on a steam jet.

"Notes on Geometrical Optics," Part II., by **Prof. S. P. Thompson, D.Sc.** Three notes were presented, the first of which dealt with the geometrical use of "focal circles" in problems relating to lenses and mirrors, and to single refracting surfaces. By "focal circles" the author means the circles having the principal foci as centres, and whose radii are equal to the focal lengths. By their use the point conjugate to any point on the principal axis is readily determined. One construction for a mirror is to draw a tangent to the focal circle from a point, P, on the axis; the foot of the perpendicular to the axis drawn through the point of

contact gives the point conjugate to P. When applied to a thin lens, a tangent is drawn, as above, to one focal circle, and the line joining the point of contact with the centre of the lens is produced to meet the other focal circle; a perpendicular to the axis from the remote point of intersection gives the conjugate point. Modifications applicable to thick lenses and single refracting surfaces were also given. In his second note the author treated similar problems by the aid of squares drawn on the principal focal distances, the constructions being remarkably simple. In the third note, the paths of rays through prisms are determined by the aid of imaginary planes representing the apparent position of the plane bisecting the dihedral angle of the prism when viewed through its two faces. Just as in problems on thick lenses in which the part between the principal planes may be supposed removed, so when dealing with prisms the part between the imaginary planes above referred to may be supposed non-existent. In another method of treatment, the apparent positions of points outside the prism when viewed from inside the prism are made use of, and their application to illustrate dispersion was pointed out. **Mr. C. V. Boys** asked whether the latter construction could be used to show why the slit of a spectroscope appears curved.

"On the Behaviour of Steel under Mechanical Stress," by **Mr. C. H. Carus-Wilson.** This is an enquiry into the properties of steel as illustrated by the stress-strain curves given in automatic diagrams from testing machines, and by magnetic changes which take place during testing. After pointing out that the permanent elongation of a bar under longitudinal stress consists of a sliding combined with an increase of volume, the author showed that the "yield" is caused by the limit of elastic resistance, ρ , parallel to one particular direction in the bar (generally at 45 deg. to the axis), being less than along any other direction. When this lower limit is reached sliding takes place in this direction until the hardening of the bar caused thereby raises the limit of elastic resistance in the direction referred to to that of the rest of the bar, after which the stress must be increased to produce further permanent set. From considerations based on the stress-strain curves of the same material when hardened to different degrees by heating and immersion, etc., it was concluded that the increase of ρ during "yield" is the same for all the specimens, and that the "yield" is a measure of the "hardness." The question of discontinuity of the curves about the "yield point" was next discussed, and evidence to the contrary given by specimens which show conclusively that the yield does not take place simultaneously at all parts of the bar, but travels along the bar as a strain wave. In these specimens the load had been removed before the wave had traversed the whole length, and the line between the strained and unstrained portions is easily recognised. As additional evidence of continuity, the close analogy between the stress-strain curves of steel of various degrees of hardness, and the isothermals of condensable gases at different temperatures when near their point of liquefaction was pointed out; the apparent discontinuity in the latter probably being due to the change from gas to liquid taking place piecemeal throughout the substance. (See Prof. J. Thomson, *Proc. Royal Society*, 71, No. 130.) In seeking for an explanation of the hardening of steel by permanent strain, the author was led to believe this due to the displacement of the atoms within the molecules of the substance. To test this hypothesis, experiments on magnetisation by stretching a bar in a magnetic field were made. These show that the magnetisation increases with the stress up to the "yield point," and is wholly permanent when approaching that point. On comparing his results with Joule's experiments on the elongation of loaded wires produced by magnetisation, the author infers that there are two kinds of elongation; firstly, that produced by relative motion of the molecules, and, secondly, an elongation resulting from a straining of the molecules themselves. To this latter straining the hardening by permanent strain is attributed, and this view seems compatible with the results of Osmond's researches on the hardening of steel.

Mr. F. C. Hawes's paper was postponed.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for the week ended December 13 amounted to £5,605.

West India and Panama Telegraph Company, Limited.—The receipts of the Company for the half-month ended December 15 were £2,803 against £2,836.

Telephone Company of Austria, Limited.—Coupon No. 10 of the 5 per cent. debentures of this Company will be paid, less income-tax, by Messrs. Martin and Co., 68, Lombard-street, on and after the 31st inst.

Anglo-Portuguese Telephone Company, Limited.—Coupon No. 4 of the 6 per cent. debentures of this Company will be paid, less income-tax, by the Alliance Bank, Bartholomew-lane, on and after January 1 next.

Great Northern Telegraph Company.—A half-yearly interim dividend at the rate of 5 per cent. per annum on the shares of the Great Northern Telegraph Company will be paid by Messrs. Hambro and Son on January 1.

Western and Brazilian Telegraph Company, Limited.—The receipts for the week ended December 13, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,017.

Manitoba Electric and Gas Light Company.—Messrs. Robert A. McLean and Co. announce that the coupons, due January 1 next, on the 6 per cent. first mortgage bonds of the Manitoba Electric and Gas Light Company will be payable by them on and after that date.

Eastern Extension (Australasia and China) Telegraph Company, Limited.—This Company notify that the coupon on their 5 per cent. Australasian Government subsidy debentures, due on January 1 next, will be paid on and after that date at Messrs. Barclay, Bevan, and Co.'s, 54, Lombard-street, E.C. Coupons must be left three clear days for examination. A quarterly interim dividend of 2s. 6d. per share has been declared by this Company, payable on the 15th prox.

Metropolitan Electric Supply Company, Limited.—The report of the Directors of this Company, made up to September 30, states that since the last general meeting important rights have been granted to the Company, with the sanction of the Board of Trade, and confirmed by Parliament. Extensive installation works have been completed, and are now supplying the electric light, and other works of the same character are in progress and approach completion, for the efficient lighting of the areas assigned to the Company. These areas are estimated to include in the aggregate about 35 miles of streets, a large number of which run through some of the wealthiest portions of the metropolis. The existing demand for the electric light far exceeds the Company's power of supply even if its authorised capital had been all called up and expended on installation works, and the Directors have under their consideration the issue of debentures at a moderate rate of interest, so as to avoid increasing the share capital at present. If, however, the anticipations of the Directors are realised, there seems little doubt that the share capital of the Company will have to be considerably augmented. The Chairman, in the evidence he gave before the Board of Trade enquiry, stated that if the Company were as successful as he expected, its share capital of £500,000 would have to be increased fourfold, and the present prospects of the Company, judging from the actual applications for the light recorded in its books, point to this estimate being verified, and to a highly satisfactory dividend being earned. With regard to the result of the Board of Trade enquiry, and the allotting of areas to various companies resulting from it, the Directors say that the result of this legislation has been to give the Company the right of supplying electricity within certain areas, and if the Board of Trade, to avoid the frequent breaking up of streets and interference with traffic, adhere to the principle laid down, that not more than two companies shall be recommended for each district—one restricted to the use of the alternate-current transformer system, and the other to the use of the continuous-current system—future competition will be limited. The Company is seeking powers to supply other areas of the metropolis, and has given the requisite notices to that effect. The position of the Company with regard to its allotted areas has been only recently sufficiently assured to warrant the Directors in completing their system of supply. It was not until after the Royal assent had been given to the Confirmatory Acts in August last, that the Company was authorised to break up streets for the purpose of laying underground mains. Notwithstanding this the Directors observe that good work has been done, and that the demands on the recently completed station at Sardinia-street are already so great as to necessitate a duplication of the existing plant.

NEW COMPANIES REGISTERED.

Morris Bros., Limited.—Registered by Kerley, Son, and Verden, 14, Great Winchester-street, E.C., with a capital of £5,000 in £1 shares. Object: to purchase the goodwill, plant, machinery, and other property and effects of the business of electricians and general scientific apparatus manufacturers carried on by Messrs. Morris Bros., at Harlington-street, Birmingham. The Company is registered without articles of association, and consequently the regulations of the first schedule of the Companies' Act, 1862, apply.

Gas Consumers' Protective Association, Limited.—Registered by Burn and Galloway, 50, Gresham-street, E.C., with a capital of £1,000 in £1 shares. Object: to protect consumers of gas, electric light or power, or water, against loss or damage in connection with the supply or consumption thereof. Most of the regulations of table A apply.

PROVISIONAL PATENTS, 1889.

DECEMBER 9.

19748. **Improvements in apparatus connected with "incandescent electric lamps" for the use of dentists, surgeons, and others.** William Broughton, 18, St. Ann's-street, Manchester.

19794. **A method of and apparatus for electrically reproducing designs at a distance.** Alexander Pelham Trotter, 28, Southampton-buildings, London.

DECEMBER 10.

19803. **Improvements in reflector adjusters for oil lamps, gas, or electric lights.** Robert Farrington Dewhurst, 356, City-road, London.

19813. **Improvements in the methods and apparatus employed in the heating, melting, and working of metals, alloys, and metalloids by the application of electric currents.** John Christian Werndeley and Henry Foster, 92, Dilston-road, Newcastle-upon-Tyne.

19831. **Quick make and break electric switches.** Charles Mark Dorman and Reginald Arthur Smith, 24, Brasenose-street, Manchester.

19835. **Improvements in electrical signalling apparatus for the prevention of collisions between railway trains.** Martin Perls and Theodor Perls, 35, Southampton-buildings, London.

19857. **Improvements in secondary battery elements.** Sir Charles Stewart Forbes, Bart., 21, Finsbury-pavement, London.

19861. **Improvements in secondary batteries.** Charles Henry Logan, 28, Southampton-buildings, London. (Complete specification.)

19875. **Improvements in electric gas-lighters and extinguishers.** Nelson Newman, 77, Chancery-lane, London. Complete specification.)

19883. **Improvements in electrical secondary batteries.** James Kent Pumpelly and Frank David Thomason, 76, Chancery-lane, London. (Complete specification.)

19892. **Improvements in machines or apparatus for welding metal by means of electricity.** Herbert Elsworth Fowler, 45, Southampton-buildings, London. (Complete specification.)

19899. **Improvements in or relating to electric batteries.** Wm. Phillips Thompson, 6, Lord-street, Liverpool. (Myron W. Parrish, United States.) (Complete specification.)

DECEMBER 11.

19946. **Improvements in telegraph transmitters.** Orville Dibble La Dow, 55, Chancery-lane, Middlesex. (Complete specification.)

19951. **Improvements in electrical switches.** Henry Bayley, 55, Chancery-lane, London.

DECEMBER 12.

20022. **A bi-planar electric switch.** Ernest Wilson, 28, Southampton-buildings, London.

DECEMBER 13.

20042. **Improved means for viewing distant and inaccessible objects by the aid of electricity.** Arthur French St. George and Agnes St. George, Redhill, Surrey.

20050. **An improved spirit or liquid measure, self-closing and self-registering, without electricity or a float.** Thomas Medley Smiddy, Sutton-street, Norton, near Malton, Yorkshire.

20059. **Improvements in and connected with electrical safety "cut-outs" and "switches."** Carrington R. G. Smythe and Ernest Payne, 140, Bath-street, Glasgow.

20079. **Improvements in fittings for outside and other electric lamps or lanterns.** Richard Hugh Hughes and Richard Seymour Hughes, 23, Southampton-buildings, Middlesex.

20082. **A method of and apparatus for signalling numerals, letters, and other symbols by electric light.** Robert T. Turnbull, 23, Southampton-buildings, London.

20105. **Improvements in electric batteries.** Gustav Louis Hille, 4, South-street, Finsbury, London.

20106. **Improvements in and connected with electric batteries.** Gustav Louis Hille, 4, South-street, Finsbury, London.

DECEMBER 14.

20163. **Improvements in propelling tricycles and other velocipedes by electricity.** Thomas Machin, 7, Staple-inn, Middlesex.

SPECIFICATIONS PUBLISHED

1888.

18505. **Electrical torches for lighting gas.** Sheridan (Culp). 8d.

18930. **Electric apparatus for indicating when machines are in motion.** Blamires and Blamires. 8d.

1889.

859. **Telephonic apparatus.** Jackson and Sinclair. 8d.

1101. **Underground electric mains.** Lowrie and Hall. 8d.

1167. **Electric circuit switches.** Lowrie and Hall. 11d.

1168. **Electric current switches.** Lowrie and Hall. 6d.

5816. **Electrical accumulators.** Langdon. 8d.

14504. **Regulating electro-motive force, &c.** Douglas and Parker. 8d.

16036. **Galvanic batteries.** Irish. 8d.

16648. **Electric railway.** Wheless and Wheatley. 8d.

16662. **Secondary batteries.** Shapleigh. 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name	Paid.	Price Wednes- day
12 Feb.	1/2	Anglo-American Brush E.L.	—	3½
12 Feb.	2/0	— Pref.	—	2½
14 Nov.	0/4½	Con Telephone & Main ...	1	3
27 July	10/0	India Rubber, G. P. & Tel.	10	17½
.....	...	House-to-House	4½	5
.....	...	Metropn Electric Supply	—	4½
.....	...	London Electric Supply ...	5	3½
.....	...	Swan United	3½	5
2 July	12/0	Telegraph Construction ...	12	45
2 July	6/0	— 6%, 1889	100	105
.....	...	National Telephone	5	6½

NOTES.

Bronze Telephone Wire.—The iron telephone wire between Rheims and Paris will be replaced by bronze wire.

Bacup.—Two electric lighting companies have written to the Bacup Town Council offering to equip the central electric lighting station, and the necessary connections for the borough.

Ship Lighting.—The two new steamboats of the German Lloyd, the "Dresden" and the "Munchen," are each fitted with an installation of electric light consisting of 340 lamps fed by dynamos of 200 amperes and 100 volts.

Egyptian Telegraphs.—Colonel Turner, commanding the Royal Engineers in Egypt, acting upon the request of the Egyptian Government, is at present inspecting the telegraphic system in Egypt with a view to improving its working.

Vienna.—The new Vienna Rath haus is being lighted by the electric light on the Egger system. Part of the installation has already been started. The rooms are thoroughly lighted with glow lamps, and the banqueting-hall is fitted with arc lamps.

Memorial to James Watt.—An attempt is being made to secure the erection of an international monument to James Watt at Greenock, his birthplace. It is proposed that the memorial shall take the form of a large and thoroughly equipped technical school.

The Statue to Joule.—The committee formed at Manchester have decided to erect a white marble statue of the late Dr. James Prescott Joule as a companion to that of the late Dr. Dalton by Sir Francis Chantrey, and also a replica in bronze to occupy some public place in the city. A large number of subscriptions have been already promised.

West Indian Cable.—A new ocean cable company is about to connect Charleston, South Carolina, with Hayti, San Domingo, Cuba, and other West Indian islands, the line extending to Martinique and thence to Venezuela. The work is to be done by a French company, and the line is likely to benefit American commercial relations with the West Indies.

Quite a Stretch.—The longest distance over which telephoning can be maintained is uncertain. Seven hundred and fifty miles is a common daily occurrence, but two gentlemen are reported, says the *New York Electrical Review*, to have quite recently carried on a protracted conversation between Charleston, S.C., and Omaha, Neb., a distance of about 1,500 miles.

Blackpool.—At a special meeting of the Blackpool Town Council last Friday, a memorial to the Board of Trade was approved and adopted, praying that a provisional order with respect to the borough may be granted to the Mayor, aldermen, and burgesses of the borough of Blackpool, and the common seal of the Corporation was ordered to be fixed to the memorial.

Water Power Plants.—An electric light plant owned by the city of Marquette, Michigan, has been put in operation by means of water power at the Bead River Falls, three miles distant. The city has acquired 400 acres of land along the river, which includes several other fine powers which can also be utilised. The plant runs 60 arc lamps of 2,000 c.p. each for the public streets.

Sewage Pumping.—The sewerage committee of Salt Lake City, Utah, have determined to summon the aid of electricity for the disposal of their sewage, not to precipitate, but to pump it. They have decided to put in a 30 h.p. standard Sprague electric motor, to run the sewage pump at the sump, and the City Street Electric Railway Company will furnish the motive power from its wires.

Spanish.—From the beginning of the year the *Scientific American*, so well known throughout the world in general, and the North of America in particular, as purveyor of scientific news, will publish a special monthly edition in Spanish, so that it will be equally well known in the numerous countries in South America, from Cuba to Chili and Brazil, where the Spanish language is almost universally spoken.

Price of Arc Lighting.—The following are the tenders received for the public arc lighting at Boston, Mass., on Nov. 29: Boston Electric Light Company, 65, 55, or 56 cts. per light per night for 1, 3, or 5 years; Charlestown Gas Company, Charlestown, Mass., 65, 55, and 50 cts.; Brookline Gas Light Company, Brookline, Mass., 57, 53, and 50 cts.; Suburban Light and Power Company, Boston, 49, 47, and 45 cts.

New Soldering Fluid.—We have tried the new soldering fluid introduced by Mr. J. H. Watkins, of Eccles, which we mentioned a week or two ago (p. 436) with the following result: It seems composed of naphtha and rosin. It solders cleaned copper, tinned iron, or brass equally well, but, of course, possesses no cleaning properties of its own. It is cleanly to use and should prove useful as a convenient substitute for powdered rosin.

Kurrachee.—There seems a probability of Kurrachee being lighted up by electric light. To test its advantages, as a preliminary measure, the Corporation have, says the *Indian Engineer*, resolved to appoint a sub-committee, composed of some of its members, to enquire fully into the practicability and advantages of the scheme being introduced in lieu of the present system of lighting the public streets, as is now done, with kerosene.

Theatre Lighting.—We understand that Mr. Harry South, who for some years has been largely associated with the electric lighting of theatres, has purchased the lease of 10 and 12, Garrick-street, Covent Garden, and will remove from 10, John-street, Adelphi, as soon as the necessary alterations are completed. A more general line of work will be added, and a department opened for the exhibition and sale of the various materials required.

St. James's Electric Lighting.—The St. James's Vestry decided to inform the solicitor to the St. James's and Pall Mall Electric Lighting Company that they cannot assent to the application for an order except on the conditions that the whole parish be a compulsory area of supply, and that before the order is granted a generating station or stations have been secured sufficient to supply the whole parish, or as an alternative, if the company fail to secure such station or stations within six months after the confirmation of the order by Parliament, the order shall *ipso facto* become void.

Electrical Apparatus for Belgium.—A victory on neutral ground has been gained by German industry in the domains of electricity. Numerous electrical projector apparatus were required, says *Kuhlows*, for the extensive fortifications on the Belgian Maas, which are now being proceeded with. Two firms competed for the order.

Sautter, of Paris, and Schuckert and Co., of Nuremberg. The experiments undertaken proved so decisive a superiority on the part of the German manufacturers that the Minister for War has placed the entire order in the hands of Messrs. Schuckert.

Bordeaux.—The port of Bordeaux, says a correspondent of *Industries*, is now being supplied with an installation of electric light. Four towers are to be erected to a height of 90ft., each to support an arc lamp of 4,000 c.p. The lamps are arranged two in series, with a pressure of 110 volts, and they are mounted on a sliding runner, so that they can be raised and lowered at will. The machines which furnish current consist of Gramme dynamos of 180 amperes and 110 volts, and running 1,000 revolutions per minute. Two other lamps will be added shortly. This improvement in the method of lighting the port will be of great benefit to shippers, especially as it will permit of the ships loading and unloading at night.

Exeter Theatre.—Of all places in the world a theatre, and that one the Exeter Theatre, should be perfectly safe in the certainty of supply of electric light. A partial failure occurred a little while ago, and again another, and this time, complete failure occurred, and oil lamps had to be resorted to. The piece that was being played was a gloomy one, requiring darkened auditorium as well as stage, so that the inconvenience was not so much felt as if it had been a more sprightly piece. It is evident, however, that uncertainty in supply of a theatre is very serious, and will naturally influence opinions on the light, and might result in more serious trouble. The theatre is supplied from the central station in New North-road, which should now be in thorough working order.

Edinburgh Exhibition.—It appears that the replies so far received by the secretary of the London Chamber of Commerce with reference to the terms negotiated by the Electrical Trades Section with the Edinburgh Exhibition authorities are favourable to the acceptance of Mr. Lee Bapt's proposals. It is therefore suggested that members who intend to exhibit should send in their entry forms direct to the exhibition authorities with the proviso that they do so on the terms of Mr. Lee Bapt's letter to the electrical section. The question of appointing technical attendants at the exhibition on behalf of the section, the choice of judges and tests will be dealt with by the committee of the section in due course, but intending exhibitors are reminded that applications for space should be made by the 31st instant.

Electric Mains at Piccadilly Circus.—At the last meeting of the London County Council, Mr. Westacott (chairman of the Highways Committee) reported that the committee had considered an application, dated November 26, 1889, from Messrs. L. Clark, Muirhead, and Co., on behalf of the St. James's and Pall Mall Electric Lighting Company, for permission to lay mains, under the license granted to the company in 1888, in the subway of Shaftesbury-avenue and through Piccadilly-circus as far as the corner of Tichborne-street, as shown upon a plan submitted with the application. The committee, having received reports from the solicitor and Mr. Gunion on the subject, saw no objection to this, provided that proper precautions be taken for securing the rights of the Council with reference to the subway; and they recommended accordingly.

Private Electric Lighting Bills.—The time for depositing private Bills in Parliament expired on Saturday last. The following relate to electric lighting: Aberdeen

Electric Lighting; City of London Electric Lighting; Dundee Gas and Electric Light; London Subways and Overhead Wires; Partick, Hillhead, and Maryhill Gas and Electricity; St. Martin's-in-the-Fields Electric Lighting; Strand Electric Lighting; Sutton, Southcoates, and Drypool Gas Company (Electric Lighting). The following relate to undertakings where electricity as motive power may be employed: Central London Railway; City of London and Southwark Subway (Clapham Extension); Glasgow District Subways; Kensington and Paddington (Subway) Railway; London Central (Subway) Railway; North and South London Subway Railway; North Metropolitan Tramways.

Non-Magnetic Watches.—One of the great problems of our present electrical age, thinks *L'Ingenieur-Conseil*, will be the construction of a watch which keeps its normal rate of going even after having been submitted to the influence of an intense magnetic field. The Bachschmid non-magnetic watch has been brought out to solve this problem in a simple and cheap manner. The wheels of steel are done away with, and the mainspring is made of a non-magnetic palladium alloy, inoxidisable even in damp air, and constant in elasticity between large ranges of temperature. "The result obtained," our contemporary goes on to say, editorially, "is perfect. We have, during two months at the Paris Exhibition, been nearly every day close to powerful dynamos at work; we have visited the central stations at Berlin, where we have been almost in contact with dynamos of 350 h.p., and we have never once had to regulate our Bachschmid watch, which cost the modest sum of 28f. We may therefore be permitted to think that this problem is satisfactorily settled."

The Central Electric Railway.—At the meeting of the Holborn District Board, Mr. H. L. Isaacs, M.P. (surveyor to the Board), reported that he had inspected the plans, etc., of the electric underground line of railway, which it is proposed to construct from Queen's-road, Bayswater, to Arthur-street West, and which is to pass beneath Regent-street, Tottenham-court-road, Bloomsbury, Holborn, and portion of the City. The length of the line was about four miles, and the depths from the surface from 43ft. to 70ft. He (Mr. Isaacs) was of opinion that subject to the promoters giving an absolute guarantee that the mode of executing the works for the railway shall be as they now state—by bringing out all the excavations on land previously acquired by them for the purpose of the stations, and taking down all the materials required for the construction of the railway at the same points—the Board should offer no opposition to the preamble of the Bill. He further recommended that satisfactory clauses be obtained for the restoration of the sewers, carriage and footways in the district, should they be disturbed. It was decided to print and circulate the report of the surveyor, and discuss it at the next meeting of the Board. Upon the same subject, at the meeting of the London County Council Mr. Boulnois, M.P., presented a petition from the inhabitants of Oxford-street asking the Council to oppose the schemes of electric railways which were attempted to be carried through Oxford-street. He moved that the petition be referred to the Parliamentary Committee, and also to the Main Drainage Committee, because the main drainage ran right down Oxford-street, and would be seriously interfered with by the proposed railway scheme. The motion was agreed to.

Birmingham Exhibition.—Mr. T. C. Sharp, the secretary and manager of the exhibition, states that a

balance-sheet has been prepared, but that it will not be possible to publish it until the result of an action against the committee which is pending has been decided. An action has been brought by a London firm who had taken a space in Bingley Hall for exhibition purposes, and who allege that it was not reserved for them as it should have been. The firm thus claim £700 damages. The action will be heard in London at an early date, and the committee have engaged counsel to appear for them. Until the result is known the committee cannot finally make up their accounts. They anticipate that they will be successful in resisting the claim, in which case there will be a balance of between £400 and £500, to be divided amongst the various medical charities. The gross receipts of the exhibition amounted to £12,000, and of that amount £2,500 was received as rent from exhibitors, and the remainder was taken at the doors. The expenses were £11,000, and amongst the items are £2,500, the cost of fitting up the hall in preparation for the exhibits; £150 for repairs to the hall after the exhibits had been removed; £120 for gold medals, and almost an equal amount for silver and bronze medals. These figures only account for less than £3,000 of the £11,000, but it is not yet stated how the balance is made up. With reference to complaints as to the delay in the distribution of the medals, it is stated that the delay has arisen chiefly by reason of the time required in preparing the design for the diploma, and also in printing it. The diploma is now in the hands of the secretary, and circulars have been now sent stating that the medals and the diplomas may be had on application at the offices.

Submarine Telephone Cable at Monte Video.—

The following are further particulars of the interesting telephone line between Buenos Ayres and Monte Video, which was publicly opened on Oct. 26—an event which commands general interest, inasmuch as there is not another line in existence working under similar conditions. The line is a duplex one, and is carried by an aerial line on either side of the River Plate, from Buenos Ayres and Monte Video respectively to the points where the river is crossed. The connection here is established by means of two submarine cables which cross the river at a breadth of 28 miles (making 56 miles of cable). The aerial line is composed of thick bronze wire. The distances as near as possible are as follows: Buenos Ayres *via* La Plata and Ensenada to Puntahara (aerial) 70 miles, Puntahara to Colonia (submarine) 28 miles, Colonia to Monte Video (aerial) 97 miles. The entire line is upwards of 186 miles long. The line was constructed by a private company, under the supervision of Mr. Emilio Laborde, and it is intended for telegraphic as well as telephonic purposes. For these reasons Rysselberghe instruments are employed, which were supplied by Moulton and Co. (now Compagnie de Telegraphie et de Telephonie Internationale of Brussels). The cables and bronze wire were supplied by the firm of Felten and Guillaume, Carlsberg, Mulheim-on-Rhine, and 11, Billiter-street, London. In the vicinity of Monte Video the bronze wire spans a distance of 460 yards across the River Santa Lucia by means of poles 36 yards in height. To witness the opening ceremony representatives of the press from Buenos Ayres and Monte Video were invited, and all acquiesce in the opinion that the working of the line was excellent, certainly not inferior to the Buenos Ayres City telephone system, both as regards articulation and the perfection with which the sound is reproduced. The charges for the use of the telephone are worthy of notice. During the

busiest part of the day they are as follows: for five minutes use, 5dols.; five to 10 minutes, 12dols. 50c.; 10 to 15 minutes, 25dols. The Felten and Guillaume cables enjoy a high repute in South America, with particular reference to their telegraph and telephone cables. In Monte Video and Buenos Ayres there are long lengths of this firm's telephone cables in use, and the success of the first submarine telephone cable is certainly gratifying to all parties concerned.

The Electric Piano.—An interesting musical novelty was lately brought before the public in Boston, U.S., being an ordinary piano, played with marvellous execution and expression by simply introducing the electric current. If the opinion of persons who have seen and heard it may be taken as an indication, this invention is likely to become an important factor in musical circles and entertainments. Apparently it was the idea of the inventor to have the electrical appliance supply exactly the place of the absent human player, and at the same time in no way to obstruct or affect the use of the piano when desired to be played in the ordinary way. The electric stroke is made at the back of the key, throwing it up, and thereby causing the hammer to strike the string, giving exactly the same motion and effect as produced by the human player when at the key-board, and not changing the regular working of the piano in any way. The force of the electric blow to produce a loud or soft note is under perfect control. The movements are obtained by the aid of electromagnets and their armatures. A rapid, certain, and durable means of producing the makes and breaks was necessary to the success of the piano, and here the inventor has adopted an ingenious and simple method of accomplishing the desired result. A spool of paper represents the music to be played in it; the notes are perforated, instead of printed, as in ordinary music. The paper passes over a small rest (called the tracker board), in which are a number of holes or air channels, corresponding to the keys of the piano, and through each one of these holes the air passes to a little pneumatic chamber placed under the rest (one of these to each key), and all of them enclosed in an air-tight box. As soon as the piano is set in motion, the spool revolves, the paper passes over the rest, in which are the little air channels, and when a perforation in the paper comes to correspond with a channel in the rest, a current of air is drawn into the pneumatic chamber, expanding it to the fullest extent. On the bottom of this chamber is a metal spring, and as the expansion takes place, this meets a contact point arranged for it; this closes the circuit, and the stroke is made by the keys. When the perforation has passed the air channel, and the solid paper again covers it, the chamber below is relieved and under pressure of the spring, and the circuit is broken; the instant another opening appears the operation is repeated, and so on. In the paper music sheet the perforation marks the duration of the note, and its relation to the other notes of the piece being played. The *tempo* is governed by the speed with which the paper passes from its spool. As this is rotated by a small motor, moving fast or slow, as much or as little air as desired can be admitted; a single slide stop brings the entire instrument under perfect control. The electric current required to operate this instrument is very small and the voltage low, not exceeding eight volts, and is absolutely harmless under any circumstances. The method adopted to obtain this light current has been to use storage cells charged from the ordinary gravity battery or from a dynamo.

FORM AND EFFICIENCY OF INCANDESCENT FILAMENTS.*

BY CHARLES J. REED.

(Concluded from page 498.)

HEAT LOST IN WIRES.

It must be remembered that the formulæ take no account of the small amount of heat that escapes by conduction through the wires. With lamps of high resistance this may safely be ignored in practice, but in changing from a long to a very short and thick filament it must be taken into account.

The following examples may serve to better illustrate the method:

Let us suppose a lamp has been constructed to give a certain candle-power on a circuit of a given pressure, and it is desired to construct other lamps having the same efficiency (temperature) and life, but of different candle-power, for the same or for different pressure. We will call this lamp for convenience the zero lamp, and denote its particular values of the variables by the subscript, o.

$$\begin{aligned} \text{Let } C &= C_o = 16 \text{ candles.} \\ c &= c_o = \cdot 6 \text{ ampere.} \\ E &= E_o = 100 \text{ volts.} \\ R &= R_o = 167 \text{ ohms.} \\ L &= L_o = 170 \text{ millimetres.} \\ r &= r_o = \cdot 07 \text{ millimetre.} \end{aligned}$$

DETERMINATION OF CONSTANTS.

The constants K, K', K'', S and S' will have the same value for all values of C, c, E, R, L, and r, and hence will be found by substituting for these quantities the simultaneous values, C_o, c_o, E_o, R_o, L_o, and r_o, respectively.

If H is measured in horse-power, we have from (1) $K = \frac{1}{746}$. From (4)

$$\begin{aligned} R_o &= S' \frac{L_o}{\pi r_o^2} \text{ or} \\ S' &= \frac{\pi R_o r_o^2}{L_o} = \frac{\pi \times 167 \times (\cdot 07)^2}{170} = \cdot 015122, \end{aligned}$$

from (3)

$$K' S = \frac{K E_o c_o}{2 \pi r_o L_o} = \frac{100 \times \cdot 6}{746 \times 2 \pi (\cdot 07) \times 170} = \cdot 0010757,$$

from (15)

$$K'' = \frac{C_o}{2 \pi r_o L_o} = \frac{16}{2 \pi (\cdot 07) \times 170} = \cdot 21399.$$

Substituting these values of K, K'', S'' and K' S, in equations (4) to (25), we are enabled to solve any problem involving R, E, C, r, c, and L, when any two of the quantities except c and r are given. The equations apply only to lamps of the same material and at the same temperature as the zero lamp. By starting with a lamp of different material, or by burning the same lamp at a different temperature, we obtain a different set of constants, which substituted in equations (4) to (25) adapt them to the changed conditions.

Suppose we wish to construct a lamp of 20 c.p. for a 90-volt circuit:

$$\begin{aligned} C &= 20. \\ E &= 90. \end{aligned}$$

From (21)

$$c = 3 \cdot 75 \frac{20}{90} = \cdot 8333 \text{ ampere}$$

from (9),

$$r = \cdot 098466 \sqrt[3]{(\cdot 8333)^2} = \cdot 087196 \text{ millimetre,}$$

from (11)

$$L = 6 \cdot 4190 \times 90 \sqrt{\cdot 087196} = 170 \cdot 59 \text{ millimetres,}$$

and from (4)

$$R = \cdot 0048134 \frac{170 \cdot 59}{(\cdot 087196)^2} = 108 \cdot 00 \text{ ohms.}$$

The calculations may be verified by substitution in some of the other formulæ.

In constructing the lamp we take a filament 170.59 millimetres long, and of such a radius that, when treated to the given process until at the proper exhaustion it takes .833 ampere with 90 volts, it will have a radius of .0872 mm. If the treatment of the carbon does not increase its diameter,

the initial and final radius will be the same; but the radius of the finished carbon is to be .0872 mm. When these conditions are fulfilled, we know with certainty that the lamp has the proper temperature if it gives twenty candles. If any single condition is not fulfilled, we know with the same certainty that the lamp has not the proper temperature. If two or more of the required conditions are simultaneously not fulfilled, then we know nothing about the resulting temperature.

LIFE AND EFFICIENCY.

We are thus enabled to construct lamps of uniform life for varying conditions of current and candle-power; and also to regulate the length of life and the efficiency, increasing or diminishing either the life or the efficiency at pleasure to suit the requirements of particular conditions, remembering always that the life and efficiency are inverse functions of each other.

The fact that the life of most commercial lamps is very irregular shows that either the material or the temperature is not uniform, and hence, that there is lack of uniformity either in the process or in the dimensions. The writer has examined a number of different makes of lamps, and found that they generally vary in length and cross-section enough to produce serious differences in temperature.

DUNDEE.

The following is Dr. Hopkinson's report on the Dundee electric lighting:

I have had the advantage of inspecting the district to be lighted, and some available sites for the generating plant, and also of conferring with a committee of Town Councillors and Gas Commissioners. I now beg to report as follows:

1. The following streets appear to be most likely to afford a certain demand for electric lighting. I recommend that they be included in your compulsory area, and that when you have obtained your Bill, mains should be laid in them at once. I assume, however, in the first instance, and until the demand is assured, only one line of main would be laid in each street, from which line consumers on either side of the street could be supplied: Nethergate to Gellatly-street, Whitehall-street, Murraygate, Panmure-street, Euclid-crescent, Euclid-street, Commercial-street, round Albert Institute to Panmure-street, Meadowsides-street, from Commercial-street to Barrack-street, by Post Office and Reform-street, Bank-street, Willison-street, Lindsay-street, from Willison-street to Nethergate, Constitution-road.

2. It would appear that there is every reason in favour, and no reason against, including the whole area of the borough in your permissive area. You will find a sufficient protection against any out-of-the-way demands in the requirement that any consumer desiring to be supplied with the light must undertake to pay you 20 per cent. on the cost of the mains required for his supply during three years.

3. The question of site for the generating station resolves itself into the question whether the generating station should be placed at the gas works, or somewhere within the compulsory area of supply. This again resolves itself into a question whether a low-tension system with direct currents should be adopted on the three-wire plan, or the alternating-current system with transformers. The latter is best adapted for use if the gas works station is selected. As regards the comparative cost of the two systems, I deal with that below. The continuous-current system, however, possesses the great advantage that it is available for supplying motive power in large or small quantities. Machines for utilising electricity for this purpose are articles of every-day manufacture, and can be bought from a large number of makers. With the alternating current, on the other hand, although many machines have been designed for the purpose of transmitting power, they are not yet in the same way articles of every-day manufacture. It may then be fairly assumed that with the continuous-current system there will be considerable demand for purposes of power; it is problematical whether there would be any demand with an alternating system.

4. *Estimate of Cost with the Alternating System.*—The plant for which I have estimated here is intended to supply 300,000 watts, or 5,000 lamps of 60 watts each. There should be three sets of machinery—that is, boilers, engines, and dynamos, any two of which should be competent to perform the whole of the work, leaving the other one spare. My estimate of cost would then stand as follows:

Distributing Conductors or Secondary Conductors.

3,000 yards of pipe at 5s. a yard laid ..	£750
Conductors, at 100 volts	780

* Read before the American Institute of Electrical Engineers, New York, November 19, 1889.

Primary Conductors.			
6,750ft. of pipe laid	...	...	551
Conductors, 1,750 yards	...	...	1,330
Plant as for Partick and Hillhead Gas	...	...	£3,411
Company	...	...	16,490
Erecting	...	...	825
Buildings	...	...	2,000
Contingencies...	...	...	2,000
			£24,726

The additional cost of adding successive increments of 2,500 lights in the same area I estimate to be as follows:

Buildings	...	...	£300
Machinery	...	...	5,200
Erection	...	...	260
Conductors, area being same	...	...	665
			£6,425

The annual charges for a plant of 5,000 lights would stand thus:

Material	...	...	£830	7	6
Wages	...	...	559	0	0
Salaries	...	...	300	0	0
Depreciation	...	...	2,472	0	0
Interest	...	...	865	4	0
			£5,026	11	6

Assuming that the demand for light was equal per diem to three hours of the maximum supply, we should have a demand of 328,300 units per annum, costing 3.7d. per unit.

The annual cost for the further plant of 2,500 lights would be as follows:

Material	...	...	£415	3	9
Wages	...	...	78	0	0
Salaries	...	...	50	0	0
Depreciation	...	...	642	0	0
Interest	...	...	225	0	0
			£1,410	3	9

or with the larger plant a cost of 3.14 pence per unit. The cost of supplying the light in the Perth-road would, on account of the greater distance to which the conductors would have to be led, be considerably greater than this. I estimate the cost of supplying 1,000 lights, or 60,000 watts, in the Perth-road to be as follows:

2,000 yards of distributing main pipes	...	...	£500
Conductor, 4,000 yards	...	...	520
Pipes for feeders, 4,000 yards, laid in same trenches, part way	...	...	900
Three feeders each, for 20 amperes only, at £39 per 1,000ft.—total length, 30,000 yards	...	...	1,170
			£3,090

costing for conductors £3 per light, instead of 14s. The appropriate additional charge for this would be £5. 3s. 6d. per unit per annum. The cost of the machinery would be practically the same as for the shorter distance, the only difference being that there will be a little more waste of power in the conductor.

5. The corresponding cost upon the three-wire system, the station to be within the area to be supplied, would be as follows:

Conductors and Distributing Mains.			
Pipes	...	...	£750
Mains	...	...	540
Feeder pipes	...	...	Nil.
Conductors	...	...	1,200
Boilers (900h.p.)	}	...	7,217
Engines		...	
Dynamos	...	...	4,200
Erecting	...	...	540
Buildings	...	...	2,500
Switchboard and instruments	...	...	400
Contingencies	...	...	1,700
			£19,047

Batteries, if used to give 60 amperes, i.e., in all 200 lights

...	...	...	£800
-----	-----	-----	------

Showing materially less cost on first outlay than in the case of the alternating system. The current charges I estimate to be as follows:

Depreciation of plant, at 10 per cent.	...	...	£1,905
Ditto battery, at 20 per cent.	...	...	160
Interest on plant, at 3½ per cent.	...	...	667
Ditto battery	...	...	28
Ground Rent	...	...	50
Taxes extra	...	...	20
Material	...	...	830
Wages	...	...	400
Salaries	...	...	300
			£4,360

From this it will be seen that there is a charge for the use of accumulators, and a lesser charge for wages. If no accumulators were used, and if the plant were run continuously day and night, the total cost would not differ materially. I set the cost of carting the coal to the station against the economy effected by direct transmission as compared with the use of transformers. To the cost as calculated above it would be necessary to add the charge made by way of royalty by the Westinghouse Company for the use of the three-wire system. What this charge is I do not know, but I imagine it would not be such as to make any material difference in the final figure. In Germany the figures range from 5s. to 15s. per horse-power, payable once for all when the installation is made. If the generating station were placed within the compulsory area of supply, the Perth-road could be supplied on one or other of three different plans. A small alternating plant might be put down in the generating station. The cost of supply would not then materially differ from the cost of supply from the gas works, the extra cost of small machinery as compared with large, being set against the additional length of conductor. A small separate plant might be established about the middle of the Perth-road for supplying the district upon the three-wire system. This would involve considerable additional cost in labour, but would effect a great economy in the cost of conductors. On the whole, I should recommend it as the best plan of the three. The third plan is to extend the system of three conductors from the generating station to the Perth-road. This is the most costly plan of all, as the following estimate will show:

Pipes, 4,000 yards at 5s.	...	...	£1,000
Distributing mains from two centres	...	...	594
Feeders	...	...	2,121
			£3,715

costing £3. 14s. per light instead of 10s. per light for conductors, or an excess of £7. 4s. per unit per annum. A separate three-wire plant in the Perth-road would cost as follows:

Feeding mains, 1,000 yards	...	...	£380
Pipes	...	...	500
Distributing mains	...	...	594
Two engines and boilers, each 120 h.p.	...	...	2,000
Two dynamos	...	...	1,200
Switchboard and instruments	...	...	100
Accumulators	...	...	800
Buildings	...	...	800
Contingencies	...	...	600
			£6,974

The probable cost of working the same would be:

10 per cent. depreciation on plant	...	...	£617
20 per cent. on accumulators	...	...	160
3½ per cent. on outlay	...	...	245
Rent of ground and taxes	...	...	10
Material	...	...	170
Wages	...	...	150
Salaries, supervision partly charged to the larger station	...	...	50
			£1,402

This shows a cost of about 5d. per unit.

6. I should suggest that you take powers to supply electricity at a charge of 6d. per unit, or 3d. per unit and £13. 15s. per unit in the maximum supply per annum, or £27. 10s. per unit in the maximum supply per annum, whichever you may in the future prefer; that you begin by charging simply by the maximum supply which any consumer may elect to take at a rate of, say, £17. 10s. per unit per annum in such maximum. This would give equivalent to 3.8d. per unit if used for 1,100 hours. You would have reasonable assurance that consumers would not wastefully consume electricity if it were pointed out to them that by so doing they would destroy their lamps, and that the cost of their lamps would be a very material part of the actual cost of the lighting. In this way you would avoid for the present having trouble with the question of meters.

7. Electromotors are made which will give 93 per cent. of the power applied to them electrically, and deliver it for useful purposes either on the belt or otherwise. Assuming, however, that small motors will give an efficiency of 75 per cent., this means 1 h.p. for each unit of electricity per hour. If the motor, then, were used at its full power for seven hours per day, excluding Sundays, it would only cost 1.9d. per h.p. per hour, a figure which is not greatly in excess of the cost of gas for a gas-engine. Electromotors are, however, cheaper and more convenient, and they take up much less room. An electromotor for 10 h.p. effective only costs about £100, and will give the user practically no trouble at all.

8. Comparing now the cost of the electrical supply proposed with that of gas, a unit of electricity will give 250 candles for an hour at a cost of 15.2d. per 1,000 candles if used for 1,100 hours. Your gas will give 1,000 candles at a cost of 12.3d. if burnt in ordinary good burners. The electric lamps may be taken as costing 3.5d. per 1,000 candle-hours.

THE ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence ; Post Free, Threepence Halfpenny.

Editorial and Publishing Offices :

139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, 139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.

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BOUND VOLUMES.

Vols. I., II., and III., new series, of "THE ELECTRICAL ENGINEER" are now ready, and can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

IMPORTANT NOTICE.

We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No paper that we know ever refuses Subscribers or Advertisers. Nor do we ; in fact, we invite them, believing that they will get full value for their money.

Specimen copies of the paper will be sent on request.

DUNDEE.

The citizens of Dundee have followed a good example in getting a report on the electric lighting of their city from such an able engineer as Dr. Hopkinson. All such reports at the present stage of the industry are exceedingly valuable, hence we do not hesitate to give it in full. At present a large amount of our work is and must be purely from supposition. We estimate this and that, especially as regards expenditure and revenue, but while the former may be approximately correct, nothing but the experience of time will give a correct value to the latter. The experience gained in America and on the Continent, or, in fact, anywhere where the conditions are different, only assists in our work without giving to it a certainty, and, further, as we have so many times said, too little is made in our estimation of the probable distribution of power. Dr. Hopkinson suggests three sets of machinery, any two of which would carry the load, leaving one set spare or under repair. It will be seen that Dr. Hopkinson depreciates the whole cost at the rate of 10 per cent. per annum. This is certainly on the safe side, and under close examination appears excessive. However, it is far better to depreciate too much than too little. If the former plan is carried out, the time comes when the plant is written down as valueless, while if too little depreciation is made, the value written down in the balance-sheet is more than the plant is worth, and so is delusive.

The prime cost, with the smaller alternating-current plant referred to, is put at 3·7 pence per unit, and this is reduced with a larger plant to 3·14 pence per unit. Alternative plans are discussed—viz., the three-wire system and several modifications—but these will be better read in the report. The last two clauses refer to motors, and to the cost as compared with gas. Dr. Hopkinson estimates that electricity could be supplied for motors at the cost of 1·9 pence per horse-power per hour, "a figure which is not greatly in excess of the cost of gas for a gas-engine." Referring to the comparison with gas, the price for electricity is about 3d. per 1,000 candles extra, but, as we again point out, to the cost of gas must be added the cost of redecoration. Taking it all in all, if this estimate is fairly correct, the cost of electricity would be less than the cost of gas.

ON THE HEATING OF CONDUCTORS BY ELECTRIC CURRENTS.—IV.

BY A. E. KENNELLY.

ON THE HEATING OF CONDUCTORS SUSPENDED IN THE OPEN AIR OVERHEAD.

For these measurements nine wires were suspended about six feet (180 centimetres) from the ground parallel to each other, one foot (30 centimetres) apart and supported on glass insulators. The current was led through these wires in series, and the potential difference between points

on each wire a measured distance apart observed in the usual way. The tests were made on two successive days,

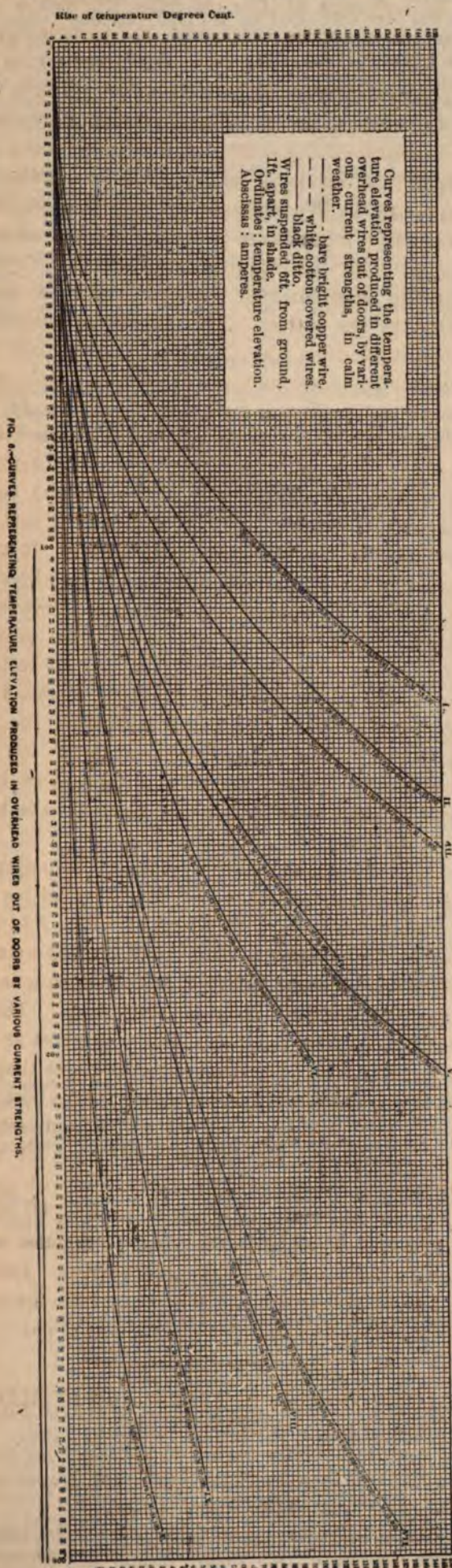


FIG. 8.—CURVES REPRESENTING TEMPERATURE ELEVATION PRODUCED IN OVERHEAD WIRES OUT OF DOORS AT VARIOUS CURRENT STRENGTHS.

four wires being tried at once on the first day and six on the second, one wire having the benefit of a second trial.

They were in the shade, and the temperature of the air was 28deg. C. by dry and 26deg. C. by wet bulb thermometer. The weather was calm, but there were at times, particularly on the second day, slight gusts and motions of the air not amounting, however, to a steady breeze. The effect of these disturbances on the temperature of the wires was so great that the readings were all very unsteady and difficult to observe. On several occasions the effect of increasing the current in the wires was not only neutralised, but even apparently reversed by an increased motion of the air. Consequently the results obtained have been much less reliable than those deduced from similar wires indoors.

There can be little doubt that if the air out of doors were as tranquil as that in a closed room, the cooling of wires would differ in those places only in respect to radiation. This is of course seldom, if ever, the case, and the effect of the air's motion in assisting convection is very great. These results may fairly serve to indicate the maximum temperature elevation overhead wires can attain in calm weather, but to what extent the convective loss of heat can attain in windy weather is not known, and is probably many times greater than that here determined.

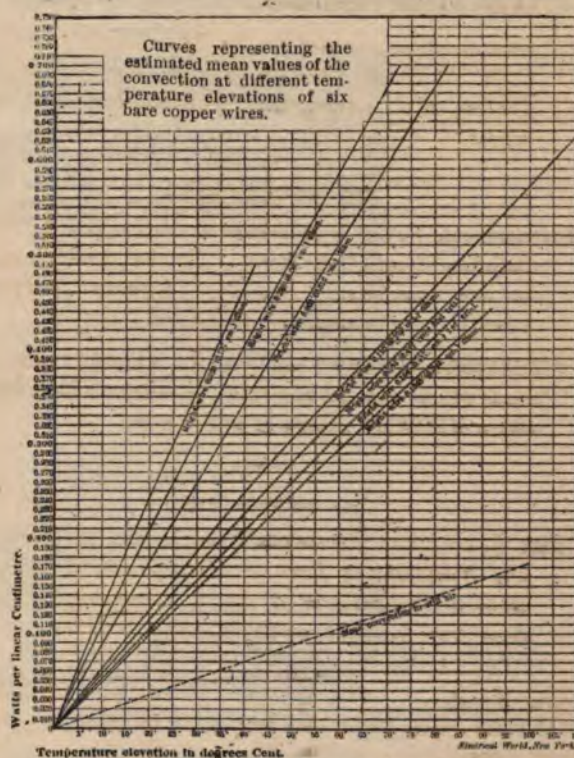


FIG. 9.—CURVES REPRESENTING VALUES OF CONVECTION.

Fig. 8 shows the curves plotted from the observations. Owing to the variation in the readings, some little judgment had to be exercised in selecting the best mean values. Two of the wires were covered with white cotton, one covered with braided and blackened cotton, while the remaining six were bare, soft copper wires, such as are generally used for overhead electric light conductors. The black-covered wire is shown to have maintained about 25 per cent. less temperature elevation than the bare wire of equal diameter and conductivity. On the other hand, the white-covered wires Nos. I. and VII. in the figure were sensibly hotter than the corresponding diameters of bare wire, the elevation of No. VII. being about 10 per cent., that of No. I nearly 50 per cent. in excess. This large excess in the latter case is, however, perhaps attributable to the fact, discovered in working out the results, that the conductivity of this wire was low, and its behaviour may not have been reliable.

The fact of the cooling of a wire being assisted by an insulating covering was pointed out on theoretical grounds by Prof. Forbes in his paper already alluded to. He showed that the greater radiating surface so obtained more than compensated, up to a certain thickness of coating, for the poor thermal conductivity of the insulator. It appears, however, that with these wires tested the white covering

formed an exception to the rule, the surface being probably less favourable to radiation.

Curves Nos. IV. and V. represent the behaviour of the same wire on the two successive days, and show the temperature elevation to have been about seven per cent. less on the second trial, owing perhaps to the greater degree of movement in the air on that occasion, as already mentioned.

Fig. 9 gives the estimated best mean values of the convection for each of the bare wires at various temperature elevations. These have been obtained by deducting from the total energy per linear centimetre the radiated loss as determined from the measurements indoors, and the difference is shown as convection in watts per linear centimetre. Owing to the great variation noticed in the convection, they cannot be regarded as more than approximations, but as far as 40deg. C. of rise they appear to be nearly straight lines, with the exception of the smallest wire. The excess of convection over that found within doors is also practically proportional to the diameter of the wire. Nor is it unreasonable that while with the convection in still air, where the energy of displacement is entirely supplied by the wire through conduction, the diameter of the wire may not play a prominent part; yet when the energy of

as within, the error involved not being large, and they can at best only fix the maximum elevation of temperature attainable in calm weather. By their use the following table has been calculated up to 1,500 amperes, although 300 amperes was the strongest testing current. To the latter limit, however, the accuracy of the table in representing the heating as actually estimated from the measurements may be judged from the following comparison between observed and calculated currents in the case of the four largest wires.

Diameter. inches.	5deg. C.		10deg. C.		20deg. C.		40deg. C.	
	Ob- served.	Calcu- lated.	Ob- served.	Calcu- lated.	Ob- served.	Calcu- lated.	Ob- served.	Calcu- lated.
0.164	54	54	72	75	95	105	127	142
0.203	72.5	72	102.5	101	145	142	195	196
0.239	93	92	140	129	192	180	250	250
0.290	155.5	123	202	170	254.5	240	305	328

RESUME OF RESULTS.

Wires in wooden panelling heated by currents are cooled by conduction under complex numerical conditions. As the temperature of the wire and panel rise, radiation and

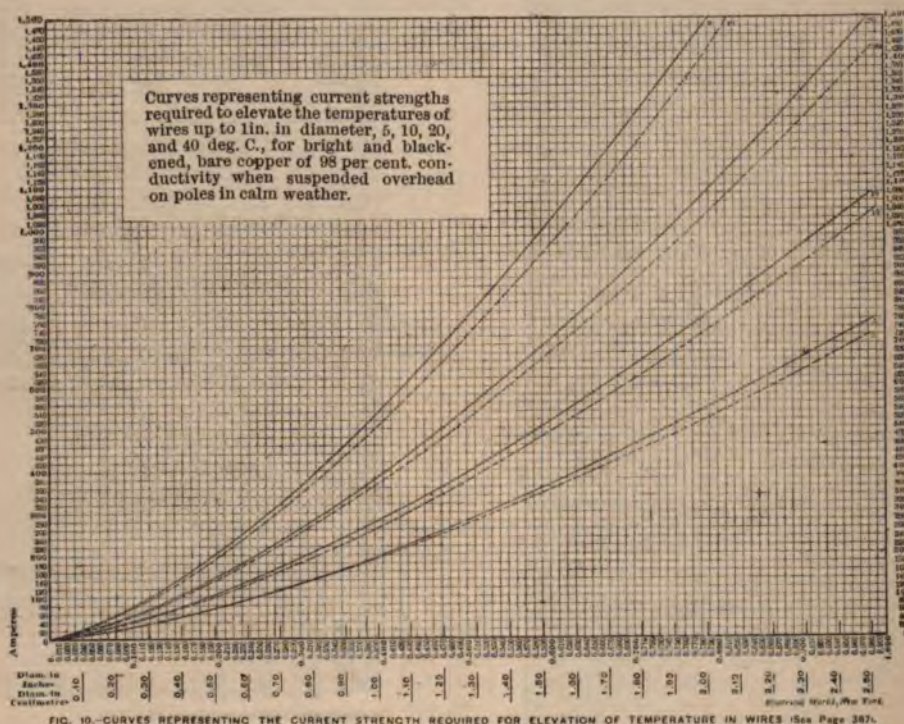


FIG. 10.—CURVES REPRESENTING THE CURRENT STRENGTH REQUIRED FOR ELEVATION OF TEMPERATURE IN WIRES (See Page 267).

the moving air is supplied from external sources, and the air passing round the wire carries off its heat, the increase of convection should depend upon the extent of the hot surface exposed, and hence be closely proportional to the diameter.

The best mean values of the convection afforded by the experiments appear to be:

$$0.00175 + 0.013d \text{ watts per linear centimetre per degree C. elevation,}$$

d being expressed in centimetres, so that the convection from an overhead wire one centimetre in diameter would be eight times as great as within doors. Modifying the previous formula to these data, it becomes:

$$c = 0.886d \sqrt{\frac{d(m\pi R_i + 0.013t) + 0.00175t}{r(1 + 0.00388T)}}$$

Simplifying, for bright copper, $m=1$,

$$\text{and } c = 28.9d \sqrt{\frac{570QR_i + 7.4dt + t}{1 + 0.00388T}};$$

and for blackened copper,

$$c = 28.9d \sqrt{\frac{1140QR_i + 7.4dt + t}{1 + 0.00388T}}.$$

These formulæ involve the assumption, known to be inaccurate, that the radiation has the same value out of doors

convection come into play. No simple and precise law can be given for the limiting temperature, but the limiting safe current approximately follows the diameter in sesquuplicate ratio, or in symbols the best empirical formula is

$$c = ad^{\frac{2}{3}}$$

Also if the limiting safe diameter of an insulated panelled wire be such that twice the proposed full load upon it shall only raise its temperature 40deg. C., then the best formula is

$$d = 0.0147c^{\frac{2}{3}}$$

d being in inches and c in amperes; or roughly,

$$d = \frac{c^{\frac{2}{3}}}{70}.$$

A bare wire in still air cools by radiation and convection. The radiation follows the law of Dulong and Petit. It varies with the surface nature of the wire, and also, strictly speaking, with the surface nature of surrounding bodies. For practical purposes, however, the environment may be left out of consideration and the radiation of a bright copper wire may be multiplied by a coefficient which is 1.7 for a surface of thin shellac varnish and 2.0 for a varnish of lampblack and shellac. The convection for small differences of temperature appears to be nearly pro-

portional to the temperature elevation, and depends, among other things, upon the form of the conductor. It also seems to increase slowly with the diameter of the wire, but more than this the measurements have not thus far determined. It may be taken approximately as 0.00175 watts per linear centimetre of all wires for each degree C. of temperature elevation.

A bare wire in air out of doors is subject to a very great increase of convective cooling even in calm weather. The convection excess over that indoors may be roughly taken as $0.013 \times d$ watts per linear centimetre per degree C. elevation in calm weather, d being the diameter of the wire in centimetres.

A coating of black cotton of ordinary thickness on a suspended wire reduces the temperature elevation, but one of white cotton seems rather to increase it.

TABLE of current strengths (minima) which will elevate the temperature of bare overhead copper wires of 98 per cent. conductivity, 5deg., 10deg., 20deg., and 40deg. C. in calm weather, for any given diameter up to one inch.

Diameter.		5deg. C.		10deg. C.		20deg. C.		40deg. C.	
Inc.	Cm.	Bright.	Blackened.	Bright.	Blackened.	Bright.	Blackened.	Bright.	Blackened.
0.05	—	12	13	17	18	23	25	30	33
0.10	—	28	30	40	42	55	57	75	78
0.15	—	48	51	67	70	94	98	130	135
0.20	—	71	74	99	105	139	148	193	201
0.25	—	98	101	136	143	190	200	264	278
0.30	—	128	131	178	186	250	260	344	360
0.35	—	160	164	224	232	312	336	426	450
0.40	—	193	201	271	284	376	390	518	546
0.45	—	220	241	321	337	446	468	616	652
0.50	—	268	282	374	393	521	548	719	761
0.55	—	308	324	430	452	599	630	825	873
0.60	—	349	367	488	514	679	714	932	990
0.65	—	390	410	550	580	762	802	1,050	1,110
0.70	—	434	456	612	626	850	893	1,170	1,240
0.75	—	480	506	677	715	940	988	1,296	1,370
0.80	—	530	556	745	786	1,030	1,080	1,440	1,510
0.85	—	580	608	816	862	1,130	1,190	—	—
0.90	—	632	662	890	934	1,230	1,300	—	—
0.95	—	688	720	960	1,010	1,340	1,410	—	—
1.00	—	740	780	1,030	1,080	1,440	1,520	—	—
—	0.2	21	23	29	31	40	44	55	59
—	0.4	52	54	71	75	100	105	139	145
—	0.6	90	93	125	132	175	184	244	256
—	0.8	139	141	192	200	268	280	370	388
—	1.0	190	196	264	276	367	380	506	533
—	1.2	245	257	343	360	478	501	660	690
—	1.4	310	325	432	453	602	632	816	877
—	1.6	375	393	525	553	728	765	1,000	1,060
—	1.8	443	465	625	660	870	910	1,190	1,260
—	2.0	517	544	728	765	1,010	1,060	1,400	1,470
—	2.2	586	624	839	880	1,160	1,220	—	—
—	2.4	680	710	950	995	1,300	1,370	—	—

This table is represented graphically by Fig. 10.

FLORENCE.

The Municipality of the city of Florence having decided to grant by means of tenders a concession for the production and transmission of the electric current, both for purposes of illumination and transmitting power, for the use of the public, herewith informs us that tenders for obtaining the said concession will be received up to February 15, 1890.

The principal clauses and conditions of the concession are as follows:

1st. That all the conductors to be used for the transmission of the electricity are to be underground.

2nd. That the difference of potential between the earth and all those parts which may be touched by those making use of the current must be below 150 volts. In the mains, however, placed underground, there may be a pressure of 1,000 volts.

3rd. That the tariff price to be charged in accordance with the energy supplied.

4th. That the concession, in consideration of the primary fitting up conceded, shall have the duration of 40 years.

5th. That the applicants for the concession shall send in documents such as to prove and show their having obtained and worked other similar concessions with satisfactory and successful results, at the same time stating what system they intend adopting for the production and transmission of the electric current.

6th. In order that tenders sent in be taken into consideration a temporary deposit of 25,000 Italian lire in cash or in Italian funds shall be made.

For all further information concerning the above concession, and, moreover, to obtain a copy of the conditions in full, as agreed upon and voted by the Municipal Council, it is necessary to apply to the secretary of the Municipality, Palazzo Vecchio, Florence.

(Segreteria del Comune di Firenze, Palazzo Vecchio.)

FACETIÆ.

When is an opera hat not an opera hat? When it's a Kapp transformer.

When is an electrician like one of his own instruments? When he is an ammete(u)r.

When does an electric light company move fastest? When it is seen tearing up the Strand.

What is the most seasonable present for an electrician abroad? A Christmas ampere from ohm.

What will happen if the Deptford installation were to break down? The shareholders would be ferrantic!

When an electrician is asked to put fresh cut-outs into a new circuit, what should he do? He should re-fuse.

The first two 1,000 h.p. converters of the L. E. S. Corporation have been nicknamed "Moody" and "Sankey."

Why could we very probably neglect to put insulation on the house wires in a transformer system? Because it is really a secondary consideration.

Voice (through the telephone): "You don't seem to recognise me." Gentleman (listening): "Well, I seem to know your face; but I can't exactly remember your name."

COMPANIES' MEETINGS.

METROPOLITAN ELECTRIC SUPPLY COMPANY.

The second ordinary general meeting of the Metropolitan Electric Supply Company, Limited, was held on Friday at Winchester House, Old Broad-street, E.C., Sir John Pender, K.C.M.G., in the chair.

The Secretary (Mr. E. Cunliffe Owen) read the notice convening the meeting.

The report of the Directors and balance-sheet were as follows:

The Directors have satisfaction in submitting the annexed statement of accounts to September 30, 1889, and in informing the shareholders of the progress made by the Company. Since the last general meeting important rights have been granted to the Company, with the sanction of the Board of Trade, and confirmed by Parliament. Extensive installation works have been completed, and are now supplying the electric light, and other works of the same character are in progress and approach completion for the efficient lighting of the areas assigned to the Company. These areas are estimated to include in the aggregate about 35 miles of streets, a large number of which run through some of the wealthiest portions of the metropolis. The existing demand for the electric light far exceeds the Company's power of supply, even if its authorised capital had been all called up and expended on installation works, and the Directors have under their consideration the issue of debentures at a moderate rate of interest, so as to avoid increasing the share capital at present. If, however, the anticipations of the Directors are realised, there seems little doubt that the share capital of the Company will have to be considerably augmented. The Chairman, in the evidence he gave before the Board of Trade enquiry, stated that if the Company were as successful as he expected, its share capital of £500,000 would have to be increased fourfold, and the present prospects of the Company, judging from the actual applications for the light recorded in its books, point to this estimate being verified, and to a highly satisfactory dividend being earned. The largest item of capital expenditure is that incurred upon the erection of the stations which are described in paragraph 10. Since the last general meeting, the Board of Trade, acting under the powers conferred upon that depar-

BALANCE-SHEET, SEPT. 30, 1889.

	£	s.	d.	£	s.	d.
To SHARE CAPITAL:—						
49,900 Ordinary Shares of £10 each	499,000	0	0			
100 Founders' Shares of £10 each.	1,000	0	0			
				500,000	0	0
„ SHARES ISSUED:—						
43,900 Ordinary Shares of £10 each on which has been called £3 per Share	131,700	0	0			
2,032 Ordinary Shares of £10 each issued as fully paid	20,320	0	0			
	152,020	0	0			
Less Calls in arrear (of which £3,426 has been since paid)...	3,785	11	0			
	148,234	9	0			
100 Founders' shares of £10 each fully paid	1,000	0	0			
				149,234	9	0
„ Loan from Bankers.....				10,043	11	3
„ Sundry Credit Balances				42,305	1	11
				£201,583	2	2
	£	s.	d.	£	s.	d.
By CAPITAL EXPENDITURE:—						
Expenditure on Stations at Whitehall, Sardinia-street, Rathbone-place, Manchester-square, Marylebone, Waterloo and Greenmore Wharves, Battery Rooms, Offices, Overhead and Underground Mains, &c.....	143,996	10	4			
Eccleston-place Property.....	12,520	7	6			
Consulting Engineer's Fees, Legal Expenses, Accountant's Charges, Maps, Plans, &c.....	1,623	0	0			
Parliamentary Expenses and Board of Trade enquiry.....	4,803	16	2			
Preliminary Expenses	5,052	10	4			
Installation and General Expenditure:—						
Engineering Department.....	2,907	16	9			
Working and maintaining the Stations, Rents, Rates, Taxes, Management, Directors' Fees, and other Expenses	13,053	6	8			
	15,961	3	5			
Less Supply of Light and Power, and other Income.....	6,127	5	2			
				9,833	18	3
				£177,830	2	7
„ Office Furniture				673	14	5
„ Stocks of Tools, Stores, Materials, &c., per valuations...				3,601	1	10
„ Sundry Debtors				9,522	18	3
„ Cash at Banks and in hand				9,955	5	1
				£201,583	2	2

ment by the Electric Lighting Acts, have held an official enquiry into the applications by this and other companies for provisional orders and licenses. This enquiry lasted through the month of April, and resulted in a valuable report by Major Marindin, the Board of Trade inspector, wherein he recommended that there should be allotted to this Company the following areas:

Under the Mid-London Order.—The whole of the areas comprised in St. Giles-in-the-Fields; St. George, Bloomsbury; St. Andrew, Holborn-above-Bars; St. George-the-Martyr; St. Sepulchre, Saffron-hill; Hatton-garden; Ely-rents and Ely-place; the Liberty of Glasshouse-yard; St. Anne, Soho; St. Paul, Covent Garden; St. John the Baptist; Savoy, or Precinct of Savoy; St. Mary-le-Grand; St. Clement Danes and the Liberty of the Rolls; together with the extra-parochial places known as the Charter House, Gray's Inn, Lincoln's Inn, Staple Inn, and Furnival's Inn.

Under the West London Order.—The whole of the parish of Marylebone.

Under the South London Order.—The whole of the parishes of St. Mary, Lambeth; St. Leonard, Streatham; and Clapham.

Under the Bill.—A portion of the parish of St. Martin-in-the-Fields.

The Directors decided not to proceed with the South London order, but propose making a fresh application for it, when they hope to make satisfactory arrangements with the local authorities with whom they were not able to settle terms within the time at their disposal. A larger portion of St. Martin-in-the-Fields than that recommended was afterwards conceded. The remaining orders were confirmed by Parliament during the last session. The result of this legislation has been to give the Company the right of supplying electricity within the above-named areas, and if the Board of Trade, to avoid the frequent breaking up of streets and interference with traffic, adhere to the principle laid down, that not more than two companies shall be recommended for each district, one restricted to the use of

the alternate-current transformer system, and the other to the use of the continuous-current system, future competition will be limited. This principle, valuable in itself, and of great service both to this Company and the public, could only be upheld after a full and exhaustive enquiry into the means of the various companies, and their proposed methods of supply. This necessarily involved considerable delay and expense, both the London County Council and the local authorities taking part in the enquiry conducted by Major Marindin, and also in the subsequent proceedings before the Committees of both Houses of Parliament. The subject has been thoroughly thrashed out, and the large and important areas assigned to this Company will be supplied with the electric light under satisfactory conditions, which have, moreover, the advantage of both departmental and parliamentary sanction. The Company is seeking powers to supply other areas of the metropolis, and has given the requisite notices to that effect. It must be understood that the position of the Company with regard to its allotted areas has been only recently sufficiently assured to warrant the Directors in completing their system of supply. It was not until after the Royal Assent had been given to the Confirmatory Acts in August last, that the Company was authorised to break up streets for the purpose of laying underground mains. Notwithstanding this, it will be seen by the following list of central stations that good work has been done, and that the demands on the recently completed station at Sardinia-street are already so great as to necessitate a duplication of the existing plant. For supplying electricity in the Company's areas, the following central stations have been erected, are in course of erection, or are about to be erected:

(1) Erected and working. (a) Whitehall Station (Continuous Current).—This station is now about to be fully employed, the demands for current being in excess of its capacity, regard being had to the requirements of Whitehall Court when completed. (b) Sardinia-street, Lincoln's-inn-fields. Alternate-Current Transformer.—This station commenced working on the 21st September last. The demand for light being in excess of the present capacity, the Directors have lately decided to order the completion of the station, by which its power of supply will be more than doubled. (c) Rathbone-place, Oxford-street (Alternate Current Transformer).—A small station on this site was purchased in February last as a going concern. Arrangements were made for the erection of a larger plant, and a portion of the new machinery is now running. The full capacity of this station is also fully engaged.

(2) In course of construction. (d) South-mews, Manchester-square, Marylebone, (Alternate-Current Transformer).—A large station is in course of construction on this site, and will, it is expected, commence working next spring. (e) Waterloo Wharf (Alternate-Current Transformer).—The machinery for this station is in a forward state, but the Directors have delayed erecting buildings owing to negotiations which are not yet concluded with the London County Council.

(3) About to be constructed. (f) A station within the Strand district (now being partially supplied from Sardinia-street). And conditionally on the Company obtaining the powers for which they are seeking: (g) A station to supply the western portion of the City, and (h) a station to supply Paddington.

The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., retire, and offer themselves for re-election.

The Chairman, in moving the adoption of the report, said the shareholders had before them a very full report of the work they had been engaged upon during the financial year which ended on September 30 last. They would notice that the whole of that period was taken up in obtaining parliamentary sanction for their schemes, and in the erection of central stations for the supply of electricity within the districts which had been allotted to them by the Legislature. They must, therefore, look upon this period as one wherein the foundations of their future success had been firmly laid, and he thought they would share with the Board in the conviction that this success was assured when they considered the large and important areas they were called upon to supply, and the enormous demand for light which met them on every side. As an illustration of the importance of their areas, he might state that it had been estimated that, putting aside the large number of non-residents who were employed in these districts during business hours, there was a resident population of upwards of 300,000. He was informed that the gas consumed in these areas represented a revenue of £337,500 a year, and, granting that they took from the gas companies a portion only of the lighting, they had every reason to anticipate a handsome income. Although they must look upon the past year as preparatory, it was satisfactory that during that period they had earned a sum of £6,127. This amount was chiefly received from the supply of light at their Whitehall station. They had thought it prudent to place that sum towards the reduction of the general expenditure of the year, so that they might be enabled to start the present financial year with a comparatively clean sheet. Practically, the whole of the expenditure last year was capital expenditure, and they would therefore have the full benefit now of the productive powers of those stations which were now completed. Full reference was made in the report to their parliamentary history. The Board of Trade, acting under the powers conferred upon them by Parliament, decided to hold an enquiry into the various provisional orders and licenses applied for by this and other companies. The enquiry lasted through the month of April, and was conducted by Major Marindin. It formed an important epoch in the history of electric lighting enterprise. A vast amount of evidence was given, and the different systems proposed to be adopted were exhaustively discussed. In the evidence which he then gave, he stated that he should not consider this Company a great success until they had quadrupled their present capital. He was still of that opinion, and when he told them that the total amount of capital embarked on the supply of electricity in London barely amounted to £3,000,000, whereas the capital of the metropolitan gas companies amounted to upwards of £13,500,000, he did not think they would accuse him of exaggeration. The result of the Board of Trade en-

of enormous benefit to the shareholders. However, in the event of their requiring more capital, they would come to the shareholders first and give them the advantage of taking up new shares. In conclusion, he said that he believed the property would become a very important one, and that those who held on to their shares would reap their reward in the way he had indicated. He then moved: "That the report of the Directors and the statement of accounts to September 30, 1889, submitted to the meeting, be received and adopted."

Sir R. N. Fowler seconded the motion.

Mr. Giles said that the statement made by the Chairman of the progress of the Company was very satisfactory. He suggested the advisability of issuing the unissued shares now that they stood at a premium.

Mr. Henderson asked if the Company had any overhead wires; also, whether the shareholders would have an opportunity of paying up in full the balance due on their shares.

The Chairman, in reply, said: As to making further calls, they wanted to be popular with the shareholders, and did not want to unduly depress the capital by calling up more money. As to overhead wires, the Government had laid down a law that overhead wires were to be dispensed with two years hence. The Company were laying their wires underground, but they had bought from the London Company a certain amount of their overhead wires, and that had been a very good bargain. He did not know that these overhead wires would be taken down in three years, but in the meantime they would be earning money by them. In the future their accounts had to be made up to December 31 in each year. When they dealt with those accounts they would also deal with the question of finance, and then they would intimate whether the shares might be paid up in advance or not.

The report and accounts were then unanimously adopted.

The retiring auditors (Messrs. Deloitte, Dever, Griffiths, and Co.) were reappointed, and

On the motion of Mr. Giles, a vote of thanks was accorded to the Chairman and Directors, and the Chairman having replied, the proceedings terminated.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts of the week ended December 20 amounted to £5,644.

West African Telegraph Company, Limited.—This Board announce the payment on January 1 next of an interim dividend of 3s. 6d. per share for the six months ended June 30 last.

Halifax and Bermudas Cable Company, Limited.—The coupons of the four-and-a-half per cent. debentures of this Company, due on the 31st inst., are payable on and after that date at the banking house of Messrs. Dimsdale, Fowler, Barnard and Dimsdales, 60, Cornhill.

Eastern and South African Telegraph Company, Limited.—This Company notify that the coupons, due January 1, on their 5 per cent. mortgage debentures will be paid on and after that date at the banking house of Messrs. Barclay, Bevan, and Co., 54, Lombard-street, E.C.

Eastern Telegraph Company, Limited.—This Company announce the payment on January 14th next of interest of 3s. per share, less income-tax, being at the rate of 6 per cent. per annum, on the preference shares of the Company, for the quarter ending December 31st, and the usual interim dividend of 2s. 6d. per share on the ordinary shares, tax free, for the quarter ended September 30th.

PROVISIONAL PATENTS, 1889.

DECEMBER 16.

20186. **Measuring or metering electric currents, as used in houses, &c., for measuring the amount of current used.** Herbert William Wilson, 61, Grove-road, Lakenham, Norwich.

20218. **Improvements in telephone transmitters.** Donald Barns Morison, 46, Lincoln's-inn-fields, London.

20235. **An improved method of and means for the production of the grids of electric accumulators in which the bars narrow from each side inwards.** Erich Correns, 89, Chancery-lane, London.

20236. **An improved combined electric igniting device and extinguishing device for lamps.** William Wilson Horn, 151, Strand, Middlesex. (Manuel Carranza, José Maria Tinoco, and Ysidro Altozano, United States.)

DECEMBER 17.

20244. **Improvements in electric generating machinery for use in connection with the electric lighting of railway trains.** John Henry Holmes, Portland-road, Newcastle-on-Tyne.

20260. **Improvements in electric semaphores.** Frederick Stitzel, Charles Weinedel, Adolph Reutlinger, Moses J. Schwartz, John H. Egelhoff, and Jacob Krieger, senr., 70, Wellington-street, Glasgow. (Complete specification.)

20261. **Improvements in electric semaphores.** Frederick Stitzel, Charles Weinedel, Adolph Reutlinger, Moses J. Schwartz, John H. Egelhoff, and Jacob Krieger, senr., 70, Wellington-street, Glasgow. (Complete specification.)

20266. **Improvements in and relating to electric spark-rupturing appliances.** Henry Harris Lake, 45, Southampton-buildings, London. (Elihu Thomson, United States.) (Complete specification.)

20288. **Improvements in conduits for electrical conductors, and in the manufacture of the same.** Henry Billington Tatham and James Tatham 47, Lincoln's-inn-fields, London. (Complete specification.)

20302. **Electrically operated alarms.** Thomas G. Lovegrove and John William Pechin, 77, Chancery-lane, London.

20311. **Improvements in or relating to lightning arresters.** William Phillips Thompson, 6, Lord-street, Liverpool. (The Westinghouse Electric Company, United States.)

20318. **Improvements in electric clocks, also applicable to electricity meters.** Anthony Reckenzaun, 20, High Holborn, London.

DECEMBER 18.

20326. **Improvements in and connected with the field-magnets of dynamo-electric machines.** Gisbert Kapp, 70, Market-street, Manchester.

20387. **An electric switch.** Joseph Devonport Finney Andrews, 23, Southampton-buildings, London. (Complete specification.)

20391. **Improvements in multiplex-telegraphy.** Charles Adolph Gisborne, 77, Chancery-lane, London. (David Herbert Keeley, Canada.)

20393. **Improvements in apparatus for lighting trains by electricity, and in the winding and regulation of dynamos for these and other purposes.** Charles Frewen Jenkin, 24, Southampton-buildings, London.

20400. **Improvements in apparatus for obtaining a record of the movements of indicators by means of electricity.** Thomas John Murday, 20, High Holborn, London. (Complete specification.)

DECEMBER 19.

20447. **Improvements in mechanical telephones.** Adam Cyrus Engert, 24, Southampton-buildings, London.

20451. **Improvements in electric safety plugs, and appliances in connection therewith.** Killingworth William Hedges, 8, Quality-court, London.

DECEMBER 20.

20486. **An improved system of distributing electricity by means of secondary generators in conjunction with underground conductors.** George Edward Barker Pritchett and Henry Robert Low, Oak Hall, Bishop's Stortford, Hertfordshire.

20516. **Improvements in the construction of secondary batteries.** Gustave Phillippart, 6, Bream's-buildings, London.

DECEMBER 21.

20565. **An arrangement of electric light for steamers' chart table or for a reading desk.** Charles H. Bell, 13, Austin Friars, London.

20582. **Improvements in electric meters and indicators.** Jacob Einstein and Sebastian Kornprobst, 53, Chancery-lane, London.

SPECIFICATIONS PUBLISHED

1888.

17155. **Electrical spring switches.** Lancaster. 8d.

17178. **Electric motors.** Mordey. 6d.

17795. **Electrical arc lamps.** Broekie. 8d.

18035. **Electro static apparatus for measuring potentials.** Sir Wm. Thomson. 11d.

18035A. **Ampere gauge and connections.** Sir Wm. Thomson. 11d.

1889.

1673. **Secondary batteries.** Phillippart. 8d.

15489. **Electricity meters.** Teague. 11d.

15820. **Secondary battery.** Smith. 8d.

16564. **Winding clocks electrically.** Lake (Morgan). 8d.

17221. **Electric telephonic apparatus.** Todd and others. 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name	Paid.	Price Wednes- day
12 Feb.	1/2	Anglo-American Brush E.L.	—	3½
12 Feb.	2/0	— Pref.	—	2½
14 Nov.	0/4½	Con Telephone & Main ...	1	½
27 July	10/0	India Rubber, G. P. & Tel.	10	17½
.....	.....	House-to-House	4½	5
.....	.....	Metropn Electric Supply	—	4½
.....	.....	London Electric Supply ...	5	3½
.....	.....	Swan United	3½	5
2 July	12/0	Telegraph Construction ...	12	45
2 July	6/0	— 6%, 1889	100	105
.....	.....	National Telephone	5	6½

